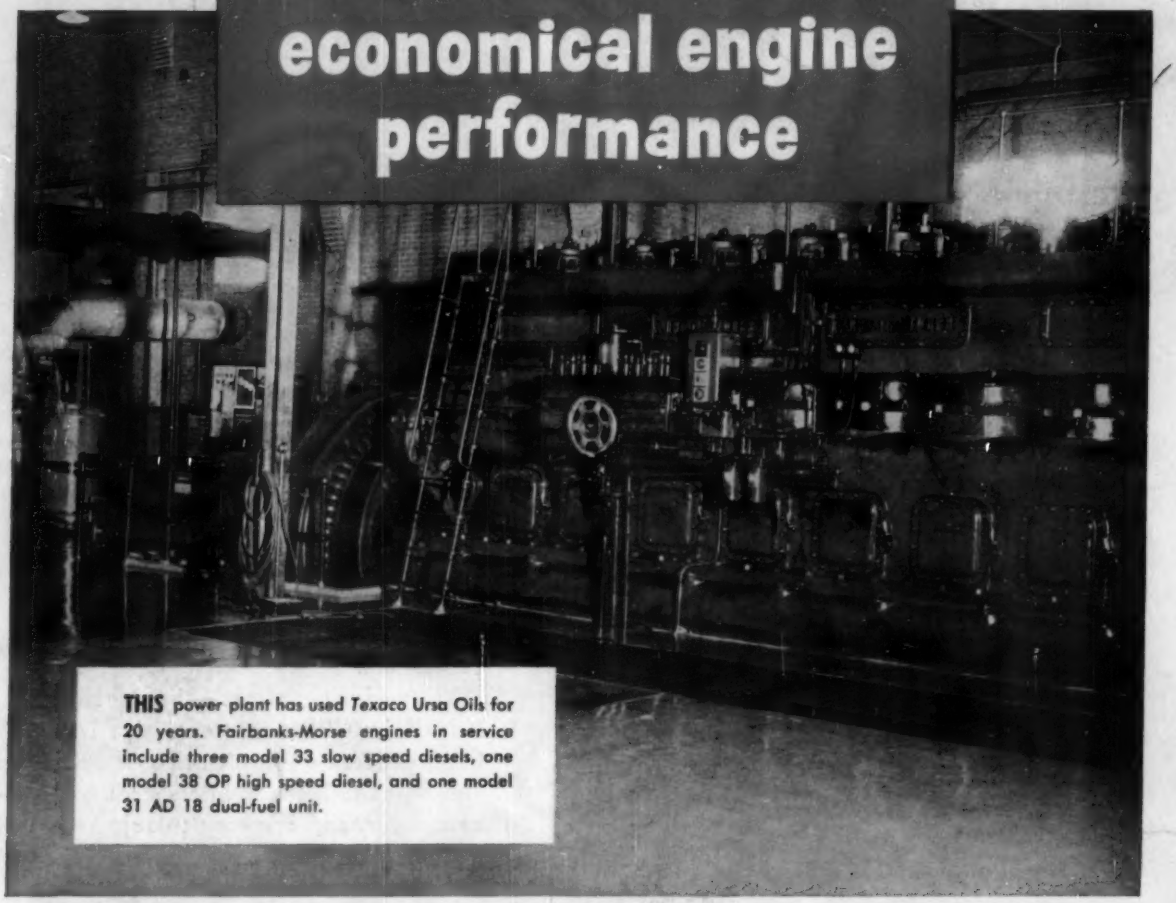
20 years of clean, economical engine performance



THIS power plant has used Texaco Ursa Oils for 20 years. Fairbanks-Morse engines in service include three model 33 slow speed diesels, one model 38 OP high speed diesel, and one model 31 AD 18 dual-fuel unit.

THIS plant (name on request) operates both straight diesel and dual-fuel engines — all of them lubricated with *Texaco Ursa Oil*. The Plant Superintendent says:

> **"Never, in more than 20 years, has Texaco Ursa Oil 'let us down.' Our engines stay clean, wear is negligible, and we enjoy real fuel economy."**

This experience is typical. *Texaco Ursa Oil* does a great job of keeping engines clean. It stands up under heat and pressure . . . stands off oxidation and sludging . . . keeps rings free for proper compression and combustion. This means you'll use less fuel . . . spend less for maintenance.

There is a complete line of *Texaco Ursa Oils* to give your diesel, gas or dual-fuel engines the best "run" for your money. Leading engine builders O.K. them, operators everywhere use them. In fact—

> **For over 20 years, more stationary diesel h.p. in the U.S. has been lubricated with Texaco than with any other brand.**

Get the full story from your Texaco Lubrication Engineer. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

☆ ☆ ☆

The Texas Company, 135 East 42nd Street, New York 17, New York.

TEXACO

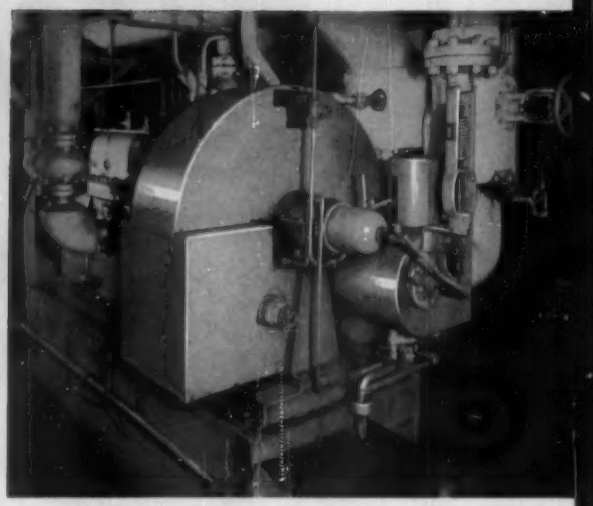
TEXACO URSA OILS

FOR ALL DIESEL, GAS AND DUAL-FUEL ENGINES

TUNE IN . . . TEXACO STAR THEATER starring JIMMY DURANTE on television . . . Saturday nights, NBC.

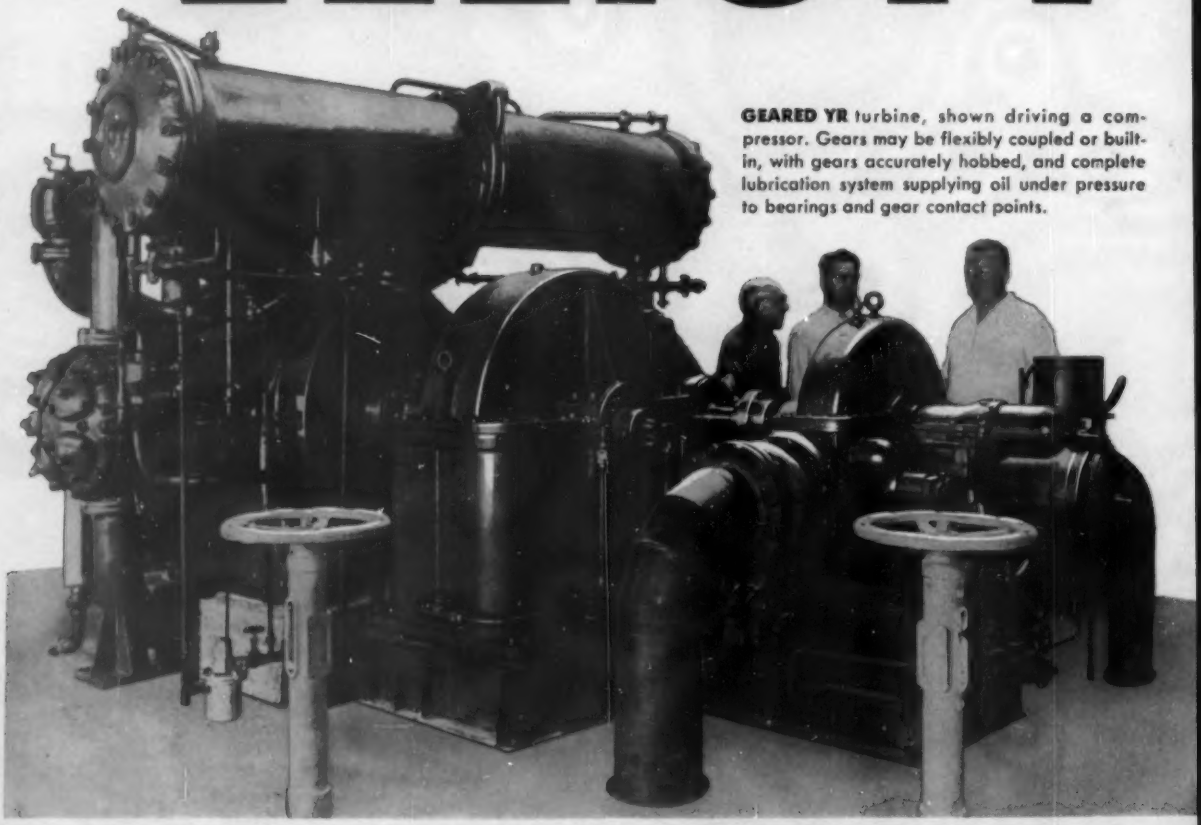
For more data circle 580 on Post Card

TYPE JR, shown driving a small pump. This is a simplified turbine design of rugged and reliable construction for low horsepower requirements and minimum first cost. Rated up to 45 hp, 4000 rpm. Maximum steam conditions—250 psig, 500 F. and 50 psig exhaust pressure.

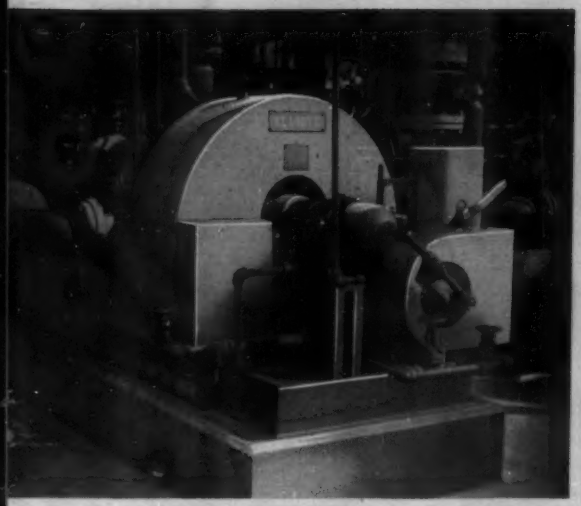


TYPE YR, here driving a boiler-feed pump. This is the standard Elliott mechanical drive turbine preferred all over industry. Five sizes—capacities up to 2000 hp, speeds to 7000 rpm. Steam conditions up to 600 psig, 750 F. and 75 psig exhaust pressure.

ELLIOTT



GEARED YR turbine, shown driving a compressor. Gears may be flexibly coupled or built-in, with gears accurately hobbed, and complete lubrication system supplying oil under pressure to bearings and gear contact points.



HIGH BACK-PRESSURE turbine, shown driving a boiler-feed pump in an oil refinery. These turbines using basic wearing parts of the standard YR, but with extra heavy casing and readily removable extra-packing glands. Good for exhaust pressures up to 250 psig.

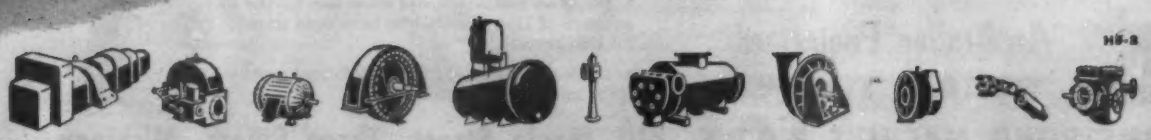
MULTISTAGE turbine, shown driving a compressor. Photo shows single-valve turbine, but multi-valve designs can be furnished. Speeds up to 11,000 rpm, steam conditions up to 850 psig, 850 F. Condensing and noncondensing ratings 400 hp and up. Custom-built to your requirements.

...the name you can depend on for all Mechanical Drive Turbine needs

WHATEVER YOUR REQUIREMENTS, the Elliott line of turbines can provide the simple, reliable answer. From the smallest type JR up to the largest multistage, Elliott mechanical drive turbines have the design, the construction and the flexibility to do the job right.

Contact your local Elliott field engineer or write Elliott Company, Jeannette, Pa. for information and descriptive bulletins.

ELLIOTT Company

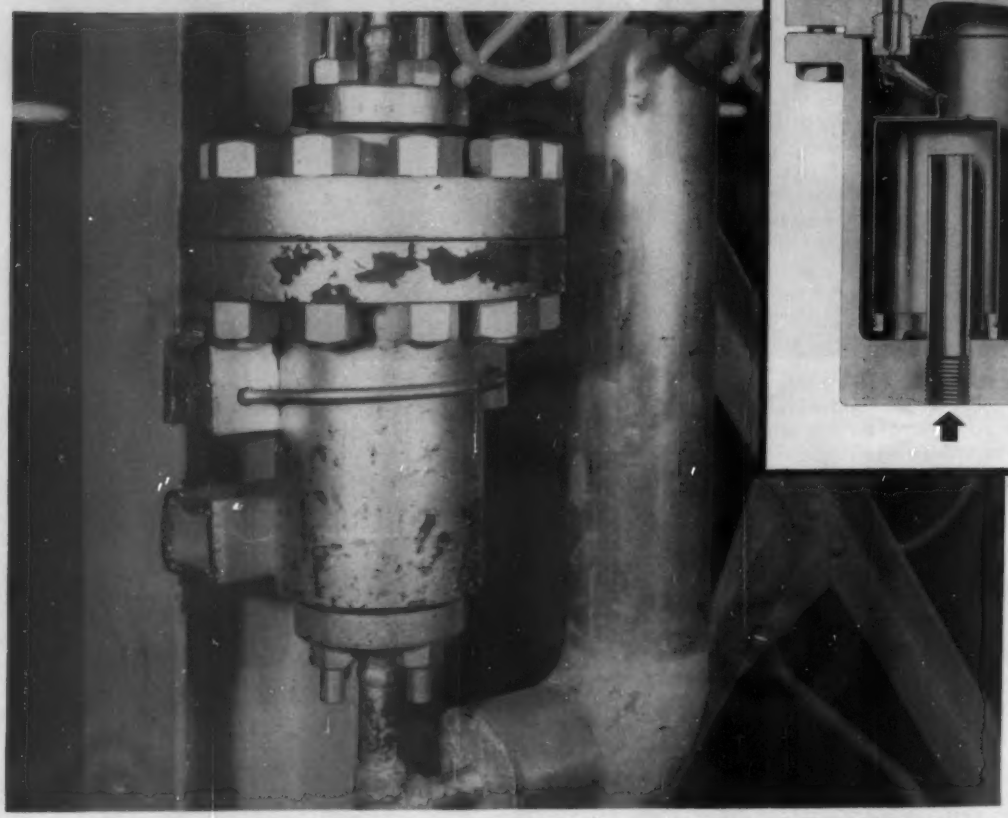


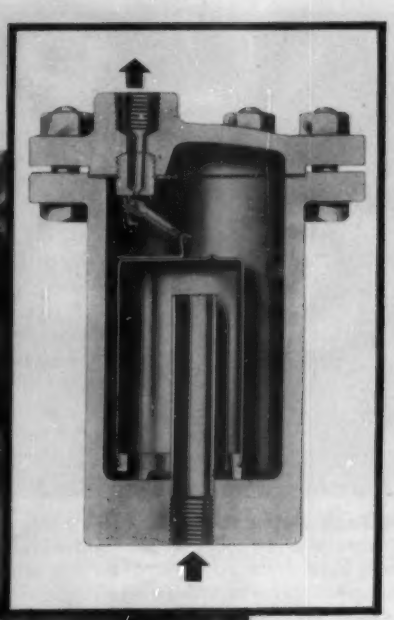
HB-8

TURBINE-GENERATORS TURBINES MOTORS GENERATORS DEAERATING HEATERS EJECTORS CONDENSERS COMPRESSORS TURBOCHARGERS TUBE CLEANERS STRAINERS

For more data circle 501 on Post Card

ARMSTRONG FORGED STEEL STEAM TRAPS . . .





. . . the Best Answer to Superheated Steam Line Drainage, because:

LIST OF MATERIALS
ARMSTRONG FORGED STEEL TRAPS

Part	Material
CAP AND BODY FORGINGS	
Up to 600 psi, 750°	1030 carbon steel
Up to 900 psi, 900°	ASTM Spec. F-1 carbon moly steel
Up to 2500 psi, above 900°	ASTM Spec. F-5 chrome moly steel
VALVE AND SEAT	Type 440 chrome steel, heat treated, standard. Stellite available.
LEVER MECHANISM	Stainless steel
BUCKET	Stainless steel
BOLTS	Class C high tensile, high temperature bolting material—125,000 min. tensile.
NUTS	Hex, semi-finish, heat treated for high pressure, high temperature service.
GASKET	Compressed graphited asbestos
INLET TUBE	Wrought iron

1. **Proved** in service in leading power plants throughout the world at pressures to 2400 psig.

2. **Experience** of Armstrong in design, manufacture and application dates back to the *beginning* of the trend to higher and higher pressures.

3. **Automatic** safety assured because of high capacity for warm-up loads; traps don't "forget" to drain the lines, and Armstrong traps *always* open for condensate.

4. **Economy** assured because of high value for price, long life with infrequent maintenance and freedom from steam loss.

5. **Quality** of workmanship and materials that is backed by a "complete satisfaction or your money back" guarantee.

SEND FOR THIS LITERATURE:

1. **Should we trap superheated steam lines?**—the answers of 11 engineers who have used traps for this service.

2. **Catalog J**—complete data on forged steel traps and steam trapping.

Application Engineered
STEAM TRAPS

ARMSTRONG MACHINE WORKS, 810 Maple Street, Three Rivers, Michigan

For more data circle 502 on Post Card

ENGINEERS' PREVIEW

NEW KNOWLEDGE of solid-state physics was called potentially one of the most important products of research described by a General Electric Co. scientist at the Geneva atomic energy conference.

Remarkable changes in the physical properties of graphite occur when it is exposed to chain-reaction bombardment in atomic reactors, Dr. W. Kelly Woods reported in his paper on Irradiation Damage to Artificial Graphite.

Under selected conditions, the strength of this form of carbon doubles; it expands in volume, and its ability to conduct heat decreases fifty-fold, he indicated.

Dr. Woods is a scientist of the General Electric Company, which operates the Hanford atom plant at Richland, Wash., for the Atomic Energy Commission.

• • •

NEW American Standard: Ring-Joint Gaskets and Grooves for Steel Pipe Flanges has been completed. It is No. ASA B16.20-1955. Copies of it may be obtained for $1.00 each through the Order Department, American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y.

• • •

ELECTRIC LOCOMOTIVES with electronic tubes will soon be replacing the original split-phase electrics on the tracks of The Virginian Railway Co. Together with the four 6800-hp motor-generator locomotives built by G.E. in 1948, they will handle all traffic on the electrified section.

Guy W. Wilson of G.E. has announced that G.E. would build twelve 3300-hp rectifier locomotives for the Virginian for use between Roanoke, Va., and Mullens, W. Va., a distance of 134 miles over mountainous territory.

Power for the new locomotives will be taken from an overhead wire, reduced in voltage by a transformer, and fed into 12 rectifier tubes which convert the alternating current to direct current for the traction motors. This order is especially significant coming during the sixtieth anniversary of main line railroad electrification in the United States. Ability of rectifier locomotives to use commercial frequency power could open up many new possible railway applications.

• • •

AS A PUBLIC SERVICE to schools, social organizations, libraries, etc., The Colorado Fuel and Iron Corp. has made available eight 16-mm sound color movies describing the production of steel, and important finished products. The manufacture of rails, wire rope, grader blades and reinforced concrete is pictured, as well as the manufacture of products essential to the mining, agricultural and construction industries.

All of these movies are available on a free loan basis, and can be obtained from The Colorado Fuel and Iron Corp., New York Advertising Department, 575 Madison Avenue, New York 22, N. Y.

• • •

PLANT MAINTENANCE & Engineering Show, one of the largest annual industrial expositions in the country, will return to Philadelphia for the 1956 event, it was announced by Clapp & Poliak, Inc., New York, producers of the show. At the same time, the 7th Plant Maintenance & Engineering Conference also will be presented.

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NBP ECA

PUBLISHED SINCE 1896 FOR POWER ENGINEERS IN PRIVATE AND PUBLIC UTILITIES AND INDUSTRIAL PLANTS

When you're at the ASME Meeting in Chicago, the editors of POWER ENGINEERING invite you and your friends to drop in at our suite in the Conrad Hilton Hotel for refreshments or a rest. We will be there between and after sessions from noon to midnight. There will be visitors' prizes.

At the Power Show in the Coliseum visit our booth No. 158

PREFERRED STANDARDS for the Presentation of Frequency Response Data (ASME Standard 107) have just been published in an 8-page booklet. You doubtless remember that we published a very clear explanation of frequency response technique and the practical results you can obtain with it in a very fine article entitled, "What the Wigglers Can Do for the Power Engineer" — December 1954 issue, page 92. That article was written by one of the leading authorities in the frequency response field, Rufus Oldenburger of Woodward-Governor Company. Dr. Oldenburger is chairman of the ASME-IRD Dynamic Systems Committee that has prepared this new ASME Standard. Copies of the Standard may be obtained for $1.00 each through the Order Department, American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y.

. . .

EDWARD R. MOORE has been promoted from assistant manager to manager of engineering for The Detroit Edison Co. Following departments of the company will report to Moore: Design Engineering, Engineering Coordination, Planning and Project Engineering, Engineering Laboratory and Research, and Nuclear Power Development. He also will serve as chairman of the Load Study Committee and as a member of the Rate Development Committee.

Moore, a native of Williamsport, Penna., earned a bachelor's degree in electrical engineering from Pennsylvania State College in 1920. He is a member and former national president of Tau Beta Pi, honorary scholastic engineering society.

Employed by Detroit Edison in 1926, he rose through various assignments to become chief engineer of the Engineering Department in 1952, and assistant manager of engineering in 1954. He is a member of AIEE and of the Engineering Society of Detroit.

. . .

WILLIAM J. FADDEN, JR., has been appointed chief mechanical engineer of The Kuljian Corp., engineers and constructors, with headquarters in Philadelphia. For a number of years Mr. Fadden has been in charge of major Kuljian projects, including the new power plant of the Central Electric Power Cooperative at Chamois, Missouri, the waste heat boiler installation for the Open Hearth Steel Mill of the Ford Motor Co.'s Rouge Power Plant, the largest private industrial power plant in the world.

Mr. Fadden has won wide recognition as the designer of the Kulculator, a circular slide chart for calculating steam pipe pressure drop and velocity. He has also written a number of technical articles for engineering publications and is a member of the ASME.

When we described Mr. Fadden's Kulculator in POWER ENGINEERING, hundreds of readers asked for them.

Daniel H. Dykins, engineer with a long record of work in the public utilities field, has been appointed manager of utilities of The Kuljian Corporation. Mr. Dykins has represented that corporation for nearly 10 years in the negotiations for steam generating stations for the Florida Power Corp., The Central Electric Power Cooperative at Chamois, Missouri, the Italian Government in Palermo, Sicily, and many others.

. . .

CARL L. BLEDSOE is chief engineer of the new Vermillion Station of the Illinois Power Co. at Oakwood, Ill. This is a single-unit, 100,000-kw station just put into service. The second unit is now under construction expected to be completed later in the year or early in 1956.

LETTERS TO THE EDITORS

Editor's Note: The last paragraph of the article, How Much Fire Protection Does a Power Plant Need? (July '55, page 78), concludes by saying "thought should be given to the protection which might be afforded exposed structural steelwork by coating it with fire retardant (not fire resistant) paint."

Curious about this statement, a reader wrote in to ask why you should not paint it with fire resistant paint. Author W. E. Rossnagel gives his answer in the following letter:

Fire Resistive Paint Not Fire Retardant

To the Editor:

THE QUESTION raised by your reader is a very natural one, and frequently asked. Yet the answer is quite simple.

Fire resistive paint is one intended to withstand relatively high temperatures without effect upon its appearance or on its protection of wood or steel against moisture. Such paint may be used to coat steam pipes, flues, stoves and other hot surfaces.

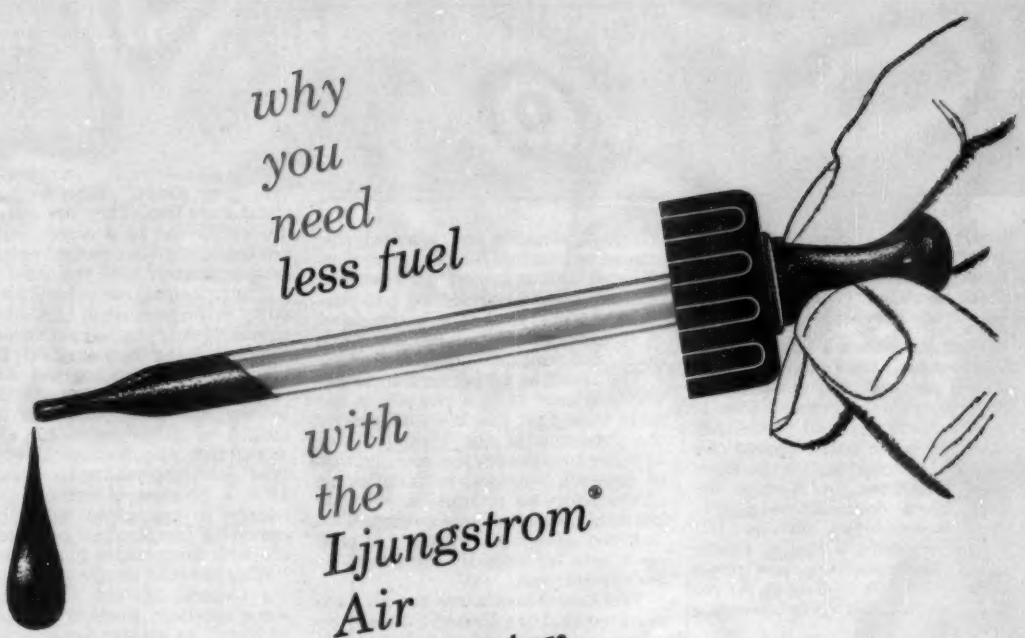
Fire retardant paint, on the other hand, is expected to change its appearance and in fact be destroyed as protection against rot or corrosion if exposed to high temperature. This kind of paint may be used alone, as a primer for a 2- or 3-coat job, or as a final coat for steelwork or wood construction. The paint, when applied, should not be materially thicker than an ordinary coat of lead and oil paint. But when exposed to superheated air or gas from a fire or to the flame the paint will expand in thickness to ½" or more, being very porous and having the appearance of a slice of toasted bread.

This porous layer acts as a heat insulator and "retards" the absorption of heat by the structural material. Eventually the heat will penetrate the expanded paint, but for the time to get an average fire under control it offers very good protection.

Heat retarding paint is sold by a number of dealers, I might mention a few: Albi-R; Halt.

I hope that this will provide the desired information for your interested reader. — *W. E. Rossnagel, Hawthorne, N. J.*

why you need less fuel with the Ljungstrom® Air Preheater

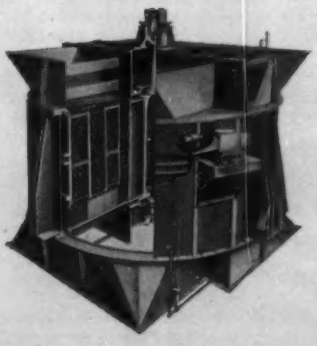


With every 45-50 F of air preheat — you cut your fuel bill 1%. That's why it pays to equip your boilers with Ljungstrom Air Preheaters. For the Ljungstrom is the most efficient air preheater there is.

Advantages of the Ljungstrom Air Preheater

- **Size for size, recovers more heat than any other type.**
- **Reduces fuel consumption. Permits use of lower-grade fuels. Increases boiler output and reliability.**
- **Eliminates cold spots . . . keeps corrosion to a minimum.**
- **Easier, faster to clean and maintain.**
- **Requires far less supporting steel and is quickly erected.**

The Ljungstrom also gives industrial plants broad latitude in their choice of fuels. Its unmatched preheating efficiency makes practical and effective such low-grade fuels as saw and paper mill refuse, wood, lignites, peat and bagasse.



Outright fuel economy is reason enough why 7 out of 10 modern preheater installations are Ljungstrom, and why Ljungstrom percentage of installed boiler capacity increases every day. Yet it's just one of the many advantages of the Ljungstrom. Get all the details on why the Ljungstrom cuts fuel costs . . . why it's the most efficient heating surface on the modern boiler . . . why it's easier to clean and maintain. All the details are in the new, 38-page reference manual, "Ljungstrom Air Preheaters." Write for it, today.

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

For more data circle 503 on Post Card

HERE'S WHAT THEY TELL US

ASSOCIATED with POWER ENGINEERING for many summers during his college years and now doing graduate work in Geneva, Patrick Malone wrote Executive Editor Earle

> Geneva has been a busy place of late. Soon after the Four-Power Conference we had the International Conference on the Peaceful Uses of Atomic Energy. I was particularly interested in the latter, because this summer I am working for the European Committee for Nuclear Research as a draftsman-designer in the syncro-cyclotron division. Our work is designing a nuclear reactor and its understructure, now under construction here in Geneva. As you might imagine, it is highly interesting work.
>
> America is not a member of CERN, but our country was represented among the exhibits displayed at the United Nations Building. Everyone was most impressed with the American exhibit of the research reactor in operation. I knew that you would also be interested, so I am enclosing their descriptive booklet.

We certainly were interested and have reproduced the cover (*below*) for our readers to see.

The booklet describes the reactor and the 14 panels which comprised the United States Exhibit at the International Conference on the Peaceful Uses of Atomic Energy, August 8 to 20, 1955.

According to the foreword, the U. S. reactor that was placed on exhibition is one of several types of compact, versatile and relatively inexpensive reactors which can be constructed and operated for research, educational and engineering test purposes. It operates at a power level of 10 kw nominal and 100 kw maximum, and contains 3.6 kg of U^{235}.

The uranium, 20 per cent enriched, which is used in this reactor, is the same type that has been offered by the President of the United States to other nations for the construction of research reactors, in furtherance of the policy to promote world-wide peaceful uses of atomic energy. Two hundred kilograms of the material have been set aside by the President for this purpose.

President Eisenhower has also announced that the United States Government is prepared to help provide research reactors for other free nations and to contribute half of the cost, as well as to furnish the nuclear fuel required.

GEO. H. HILL, JR., Tar Products Division Maintenance Engineer, Koppers Company, Inc., wrote Editor Kramer

> Dick Morris sent me a copy of your very excellent booklet entitled A Power Plant Primer. We have read this and passed it around. The consensus is that it is the finest thing of its kind we have ever seen. We should like to put one into the hands of each man who has anything to do with the operation of our boilers or who is responsible for the use of steam.
>
> With this in mind will you please advise us if these are still available, and the price of 50 to 100 copies?

The Primer is now in its fourth printing, and copies are available.

INTERESTED in recent publicity on the free piston gas generator, an industrial consultant said

> I would be grateful if you could advise me as to the general level of developmental work being conducted on the free piston gas generators, their gas turbines and transmission equipment and what firms are engaged in the research.

Our country is badly lagging behind France in this development. Responsible for their head start is Societe Industrielle Generale de Mecanique Appliquee, 61 Avenue Franklin D. Roosevelt, Paris VIII, France.

These people have 46 free piston turbines with 102 gas generators either in service or scheduled for early completion. The horsepower represented comes to 102,000 shp. Efficiencies compare favorably with the diesel engine, but they can use heavy oil fuels.

One popular misconception about the "free piston" unit is that the pistons are free. They are not. They are not linked to a crank, but they are linked together so that one moves proportionately with the other.

The principal reason for their popularity is the promise of high efficiency equalled only by hypothetical gas turbines using hypothetical turbine blade materials. Since the work of compressing the air supply is done in the gas generator, the turbine output is all available for external work; this also reduces the turbine inlet gas temperature to about 900–1000 F because of the compression energy it has given up. The low operating temperature promises long life with inexpensive blade metals.

This low inlet temperature is tempting General Motors who are doing some excellent work in this country to install an afterburner between the gas generator and the turbine.

SPEAKING OF G-M and horsepower, remember the estimate on the total installed horsepower of this country given in our September issue? We said the total capacity installed was over 2,500,000,000 hp which is correct for an approximate estimate.

To be a little more accurate, however, the item in this detailed breakdown, showing capacity installed in wind power, farm tractors, earth-moving machinery, railroads, etc., should be greatly increased, although it will not make much difference in the total. This higher figure was recently released by General Motors Corp. at the opening of its Powerama in Chicago. G-M President Curtice said that it signalized an important milestone — the production by G-M of 100,000,000 diesel hp.

Incidentally, this is more than the total installed capacity of all the nation's privately-owned steam electric generating plants. A great deal of this diesel capacity went into marine applications — possibly more than half. The other 50,000,000 hp went into earth-moving machinery, railroad equipment, farm equipment, and the like, and some stationary applications. So that, together with the capacity built by other diesel-engine manufacturers, would probably raise the total in this one item to at least 75,000,000 hp, and accordingly raise the total installed capacity to 2,739,000,000 hp. If you think of the total power capacity for the country as being somewhere between 2,500,000,000 and 2,750,000,000 hp, you won't be far wrong and you may even be a little low.

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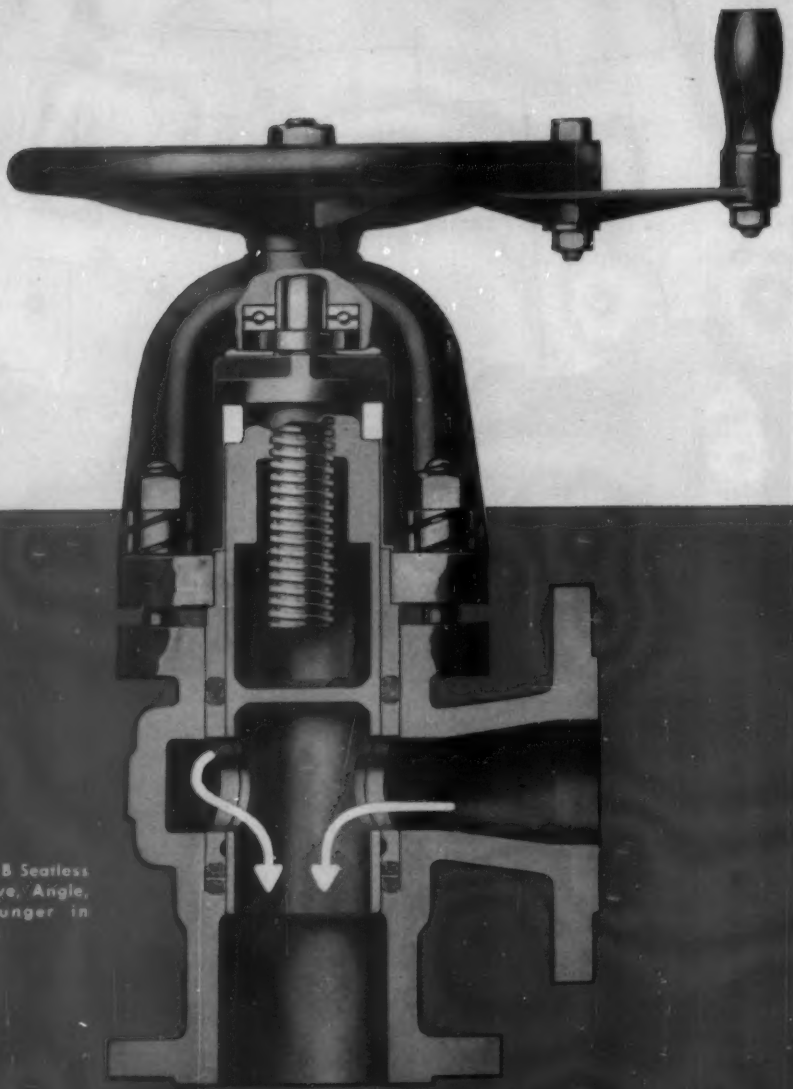
seatless

. . . for



Yarway Type B Seatless Blow-Off Valve, Angle, showing plunger in open position.

YARWAY

trouble-free blow-down service

YARWAY SEATLESS BLOW-OFF VALVES

"Trouble preventers" is what YARWAY Seatless Blow-Off Valves are often called because they eliminate one of the commonest sources of trouble in low and medium pressure boiler blow-down service. *There is NO SEAT to score, wear, clog or leak.*

YARWAY Seatless Blow-Off Valves feature a balanced, sliding, hollow plunger design that permits free and easy operation—full, unobstructed flow.

More than 16,000 boiler plants today use YARWAY *Blow-Off Valves.*

YARWAY Bulletin B-426 shows all the latest types and features of YARWAY Seatless Blow-Off Valves. If you operate your boilers up to 400 psi, you'll find a copy helpful. For higher pressures, ask for Bulletin B-434. Write today.

YARNALL-WARING COMPANY
100 Mermaid Ave., Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

Yarway Type B Seatless Tandem Blow-Off Valve. Angle-angle combination. Pressures to 400 psi.
Yarway Type B Seatless Blow-Off Valve, Straightway. Pressures to 400 psi.
Yarway Type B Seatless Tandem Blow-Off Valve, Angle—Straightway. Pressures to 400 psi.
Yarway Type B Seatless Blow-Off Valve, Angle. Pressures to 400 psi.

— blow-off valves

For more data circle 305 on Post Card

Controlling Cyclones Electronically

CONTROL OF OVER 130 BOILER FUNCTIONS

at Ridgeland is centralized on these Republic electronic benchboards.

RIDGELAND STATION
Stickney, Illinois
Units 1 and 2 consist of four superheat cool and gas fired boilers operating at 1800 psi and 1050°F. Units 3 and 4 consist of two coal fired reheat boilers operating at 1900 psi and 1050°F/1000°F.
Sargent and Lundy, Consulting Engineers

at RIDGELAND

Commonwealth Edison's Ridgeland Station near Chicago is the largest completely cyclone-fired power plant in the world. A total of 28 cyclone furnaces fire the plant's six boilers which together can generate enough steam to supply four turbine-generator units with a net capability of 640,000 kilowatts.

To maintain maximum firing efficiency, combustion conditions **at each cyclone** are individually controlled and integrated with over-all plant operation by a Republic Electronic Combustion Control System. The system provides separate controls for primary air, secondary air, fuel feed and fuel-air ratio at each of the 28 cyclone furnaces in addition to controlling forced and induced draft fans and feedwater pumps on each boiler. All told, there are more than 130 individual controls which are automatically coordinated for continuous proper combustion.

Republic Electronic Controls handle all of these functions without introducing transmission lags, complicated pneumatic-mechanical linkages and inaccuracies due to mechanical inertia into the control system. Intergration of control information is greatly simplified by the use of electronic circuits. Expensive panel piping is eliminated and control panels are easier to operate. Because transmission of control impulses is electrical, all parts of the control system can respond simultaneously for smooth, coordinated operation of the boilers.

Ridgeland is but one of many modern cyclone-fired power plants that are equipped with Republic Combustion Controls. In fact, more cyclones are controlled by Republic than by any other make of controls.

Where new developments such as cyclone furnaces call for new control techniques, you'll find Republic engineers and modern Republic equipment up to the task of devising combustion control systems that will meet the requirements of maximum efficiency, dependability and easy operation.

Write us when your problem is combustion controls.

REPUBLIC Automatic
COMBUSTION CONTROLS
(pneumatic or electric)

- **FOR ALL SIZES AND TYPES OF BOILERS**
- **FOR ALL METHODS OF FUEL FIRING**
- **FOR ALL LOAD CONDITIONS**
- **FOR ALL ARRANGEMENTS OF DRAFT**

REPUBLIC FLOW METERS CO. ● 2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS

For more data circle 506 on Post Card

Flintkote Company *Modernized* a Power Plant

when Flintkote Company modernized its power plant at its Ridgefield Park, N. J. building-paper mill it went all out

and now gets

20% more steam
21% more efficiency
33% savings in fuel cost
33% less maintenance costs

. . . proving that it pays to modernize

CONGRATULATIONS

to The Flintkote Company for its citation received in POWER'S 1955 Modernization Program

Five out of twelve citation winners for their modernization of steam-power facilities feature Riley Steam Generating Units and Riley Fuel Burning Equipment

Power
MODERNIZATION
PROGRAM

the others are:

Bendix Products Division, Bendix Aviation Corp., South Bend, Ind.

Carbide & Carbon Co., Blaine Island, So. Charleston, W. Va.

The Garlock Packing Co., Palmyra, N. Y.

The Pennsylvania Railroad, Juniata Shops, Altoona, Pa.

FLINTKOTE'S PROBLEMS:

- Increase steam capacity to provide 20% margin for future requirements.
- Increase steam generating efficiency.
- Utilize two lower cost fuels, bituminous coal and #6 oil, in place of anthracite.
- Provide for possible future shortage of one of these fuels.
- Reduce average $20,000 annual maintenance cost.
- Complete modernization without interrupting production
- Utilize existing plant building.

RX:

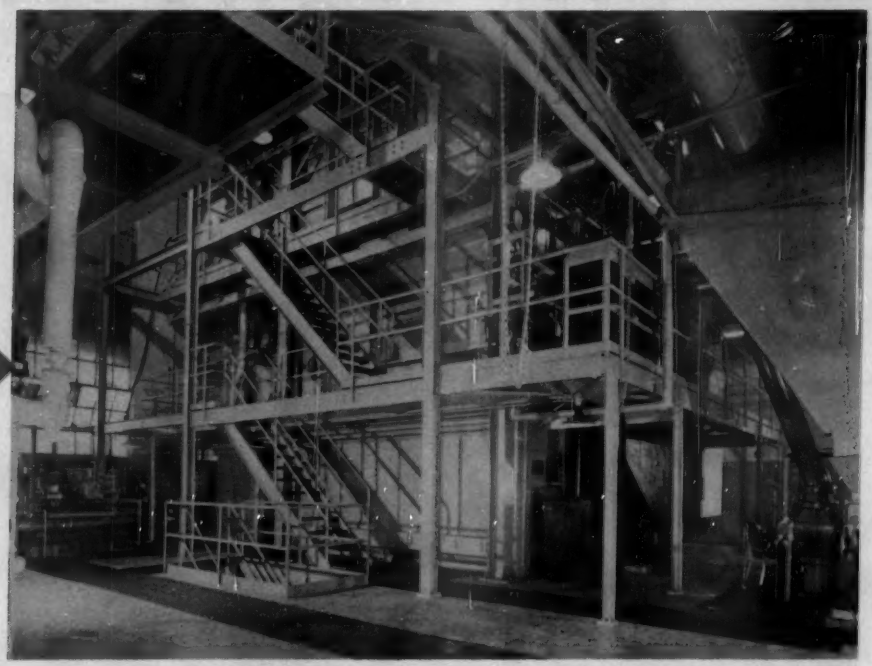
- Replace two older stoker fired units burning anthracite with a Riley Unit fired by Riley Flare Type Burners and Riley Pulverizers.
- Overhaul and convert one of the three old units to oil firing as standby unit.
- Provide automatic combustion controls and up-to-date coal handling and ash removal systems.

RESULTS:

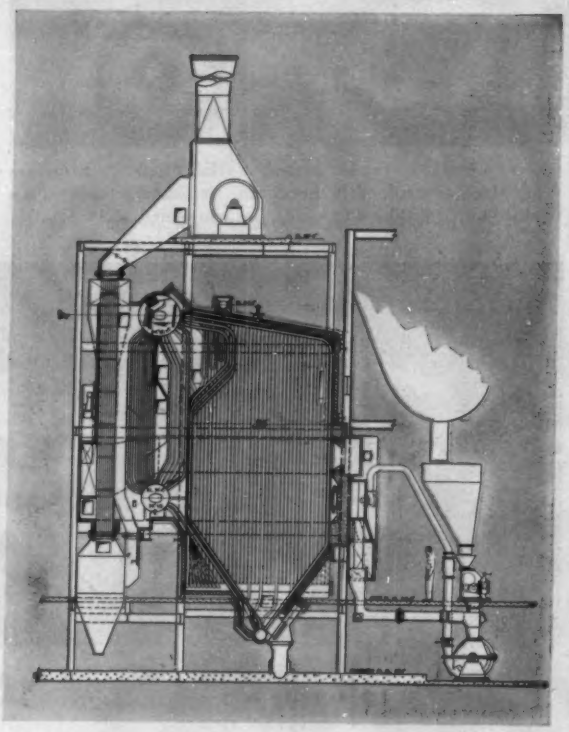
- Work was accomplished without interruption to paper mill production; tie-ins were made during normal plant shutdown.
- Operators were thoroughly trained to fire new fuels and equipment.
- Efficiency increased from 71% to over 86%.
- Fuel costs were lowered from 67.5c per 1000 lbs. of steam to 46c per 1000 lbs. of steam with a total annual savings in fuel costs of $55,000 plus a substantially reduced maintenance cost.

RILEY designs, engineers, manufactures and erects complete steam generating units for Public Utility Central Stations and Industrial Power and Heating Plants

and now saves $55,000 on fuel costs alone



with RILEY Steam Generating and Fuel Burning Equipment



Engineering Data of Equipment furnished to Flintkote Co. by RILEY

One 60,000 lbs/hr RX Steam Generating Unit complete with Riley Air Heater, Superheater and featuring patented Riley Single Header Hopper Bottom; Two Riley Flare Type Burners

*One Riley 50 Pulverizer
Guaranteed Efficiency at 60,000 lbs/hr — 85.3%
Actual Operating Efficiency exceeding 86%.

*It will pay you to investigate the savings that can be affected when you install Riley Pulverizers to fire boilers of 50,000 to 75,000 lbs/hr capacity.

A survey of your plant by a consulting engineer could show ways of making surprising savings in your power costs.

RILEY
Stoker Corporation
WORCESTER, MASSACHUSETTS

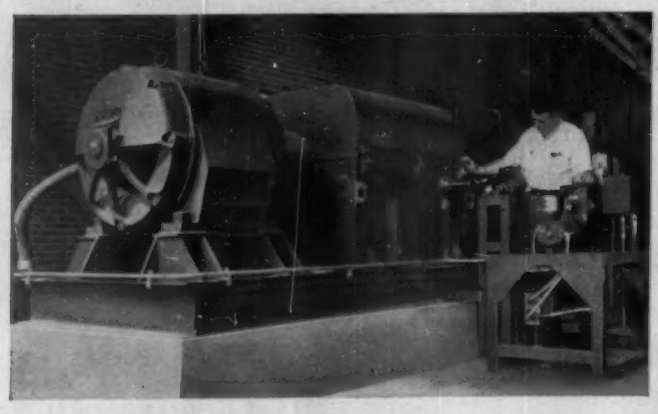
Sales Offices: Worcester, New York, Philadelphia, Buffalo, Washington, Pittsburgh, Cleveland, Detroit, Chicago, Cincinnati, Charlotte, New Orleans, Atlanta, St. Louis, Kansas City, St. Paul, Houston, Denver, Salt Lake City, Los Angeles, San Francisco, Portland, Seattle.

For more data circle 507 on Post Card

Iowa Electric Light & Power's kw

Iowa Electric's new Sutherland Station, under construction at Marshalltown, will have two generating units. First unit, with 33,000 kw capacity, was completed in 1955.

American Blower Induced Draft Fans on Sutherland Station's new No. 1 unit are rated @ 97,000 cfm @ 356° F @ 11.75" sp @ 239.0 bhp.



Driving induced draft fan, American Blower Gyrol Fluid Drive – class IV, type VS – provides adjustable speed control; is rated @ 250 hp @ 870 rpm.

sales increase 356% in 17 years!

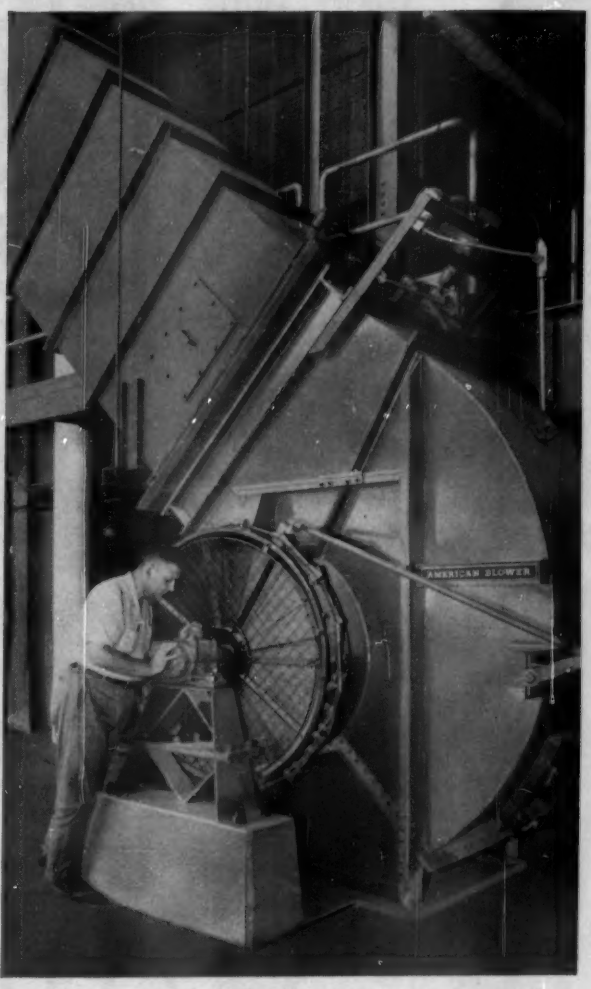
Relying on experience, rapidly expanding utility chooses American Blower air-handling equipment

1936 ushered in a phenomenal growth period for the Iowa Electric Light and Power Company. Fast-rising electrical needs called for new and larger facilities, longer distribution lines. Two mergers extended the company's operations. By 1953, 17 years later, Iowa Electric was serving 51 counties – and kilowatt-hour sales were up 356%! Today, Iowa Electric's facilities are still mushrooming. And the end is nowhere in sight!

Expansion has included new electrical generating units at the Boone and Cedar Rapids Plants . . . where American Blower Forced and Induced Draft Fans, Gyrol Fluid Drives, and a Fly Ash Precipitator were installed. This equipment has proved so dependable and free of maintenance that Iowa Electric again chose American Blower for Sutherland Station, its new plant at Marshalltown, completed in 1955 (first of two units to be constructed).

Experience has led many other progressive, investor-owned utilities to specify American Blower again and again, when expanding or modernizing. "There's no substitute," they report, "for the quality of American Blower Mechanical Draft Fans, Fly Ash Precipitators, Heavy-Duty Steam Coils, and Gyrol Fluid Drives for boiler feed pump and fan control." They rely on American Blower . . . you can too.

American Blower branch offices are conveniently located throughout the U.S. You'll find one of our representatives easy to contact – to discuss *your* problems.



No. 1 unit at Sutherland Station uses American Blower Forced Draft Fans, each with 57,500 cfm capacity @ 120° F @ 11.6" sp @ 138.0 bhp.

AMERICAN BLOWER CORPORATION
DETROIT 32, MICHIGAN

CANADIAN SIROCCO COMPANY, LTD.
WINDSOR, ONTARIO

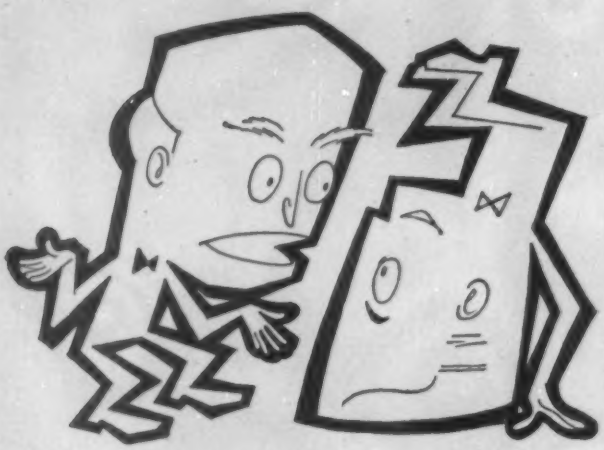
Division of American Radiator & Standard Sanitary Corporation

AMERICAN BLOWER

For more data circle 508 on Post Card

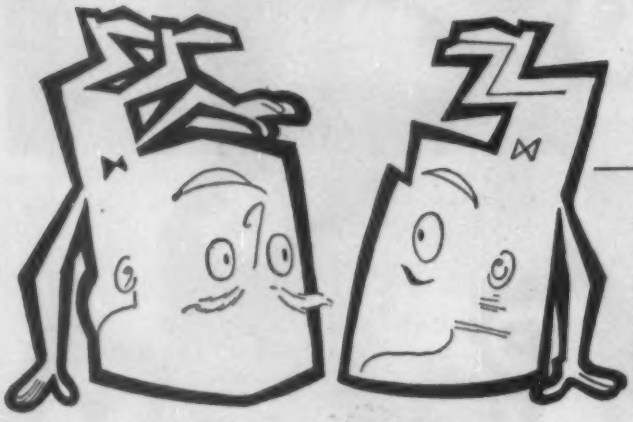
Our coal bills are lower than they used to be. Are we getting cheaper coal?

No. The coal may be higher priced, but it just costs less.



Man, you've gone crazy! Telling me high-priced coal costs less.

That's exactly what I mean. This coal has less moisture and less ash. That leaves more usable coal in every ton. It burns better in our type of boiler. Add it up, and we're getting the same amount of steam with a lot less coal.



How did you find out about this coal?

I asked the Chesapeake and Ohio coal people to recommend a coal that would give less smoke. The coal they suggested not only burns practically smokelessly, but as you see for yourself, it costs less. I used to buy coal strictly on price, but I know better now. Picking the right coal for any particular set of conditions is a job for an expert.

P.S.

There's a lot more to buying coal than the cost per ton. Why not contact coal producers on the C&O to solve your particular fuel requirements, or write to: R. C. Riedinger, General Coal Traffic Manager, Chesapeake and Ohio Railway Company, Terminal Tower, Cleveland 1, Ohio.

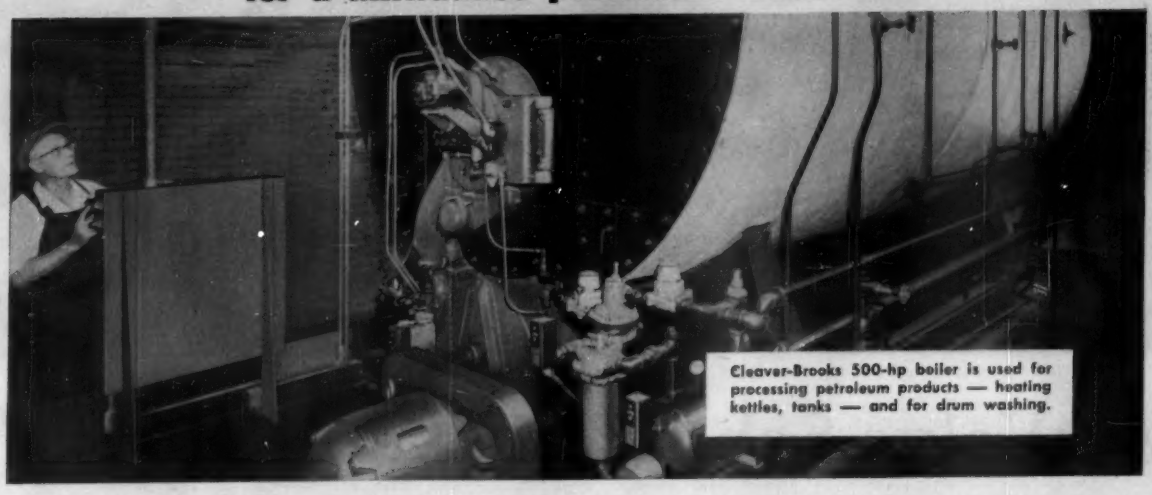
Chesapeake and Ohio Railway

WORLD'S LARGEST CARRIER OF BITUMINOUS COAL

For more data circle 509 on Post Card

"We heard Cleaver-Brooks Boilers were OK"

. . . and what an understatement that proved to be for a Milwaukee petroleum marketer*



Cleaver-Brooks 500-hp boiler is used for processing petroleum products — heating kettles, tanks — and for drum washing.

Look at the record:

350 gallons of fuel oil saved per day!

On an annual basis — that's more than 90,000 gallons of oil saved.

Complete shutdown flexibility with the assurance of fast steaming from a cold start is the key to these remarkable savings for a petroleum processor and marketer in Milwaukee, Wisconsin. Now, a Cleaver-Brooks 500-hp boiler operates 10 hours a day, 5 days a week, where formerly two 150-hp units operated continuously 24 hours a day, 7 days a week. Fewer boiler working hours also saves up to $11,000 yearly in maintenance.

By replacing outmoded equipment, this petroleum processor also enjoys the benefits of guaranteed 80% operating efficiency, four-pass design, forced draft, 5 sq. ft. of heating surface per boiler-hp and fully-automatic firing. Cleaver-Brooks Company, Dept. K, 311 E. Keefe Ave., Milwaukee 12, Wisconsin — Cable Address: CLEBRO — Milwaukee — all codes.

*Name supplied upon request.

Look at these "before-and-after" facts

	NEW (1) 500-hp Cleaver-Brooks boiler	OLD (2) 150-hp obsolete boilers
FUEL CONSUMPTION	450 gal. per day (10-hr. day) 46 gal. per hour (operating hour)	800 gal. per day (24-hr. day) 60 gal. per hour (operating hour)
SCHEDULED STEAM SERVICE	Automatic firing from 6:30 a.m. to 4:30 p.m. Fast steaming from a cold start.	Continuous 24-hr. operation. Couldn't shut down. Wasted heat. No benefit from extra hours of operation.
OVERALL EFFICIENCY	Average 125 lb. of steam per gal. of oil.	Average 96 lb. of steam per gal. of oil.
OVERALL MAINTENANCE	Cleaned every 6 months. Single maintenance foreman.	Cleaned every 6 weeks. Required extra fireman for weekends.

Let us help you beat the penalties of boiler obsolescence — with a modern Cleaver-Brooks installation. Sizes from 15 to 600 hp, 15 to 250 psi — steam or hot water, for heating or processing. Write for catalog.

Cleaver Brooks 25th YEAR

TWENTY-FIVE YEARS OF LEADERSHIP BY THE ORIGINATORS OF THE SELF-CONTAINED BOILER

For more data circle 510 on Post Card

A "Valve School" Takes the Road

Factory-trained engineer conducts Valvemobile tour

Nearly 250 key personnel each week in power, petroleum and industrial plants throughout the country hear the inside story of steel valves, their installation, operation, and maintenance when the Edward Valvemobile stops right in their own backyard.

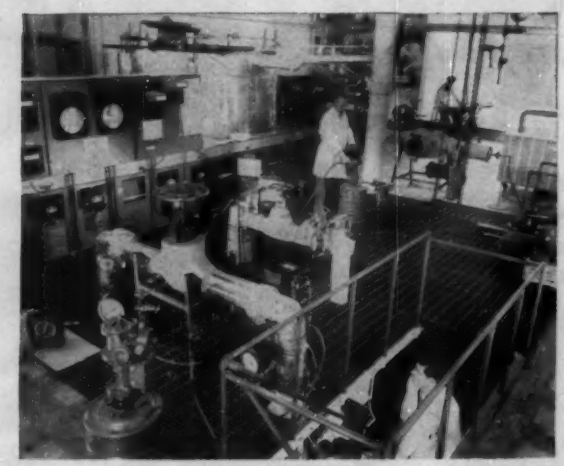
This 23-foot traveling "valve school" is crammed full of educational material to help valve users obtain better valve performance. Almost 40 sectioned valves literally give the inside story of valve operation. Diagrams, photographs, models and a color-slide lecture further describe valve procedures.

Edward developments which have become valve industry standards over the years are featured in the valvemobile, too. Inclined stem forged steel valves, Impactor handwheels, Equalizers for check and non-return valves; EValthrust yoke bushings; streamlined internal contours, and cored-out guide ribs are only a few of the Edward "firsts" displayed.

To conduct the program and answer questions, a competent valve engineer accompanies the Valvemobile on its visits. The engineer also demonstrates methods for repairing valves.

Rockwell-built Edward Valves

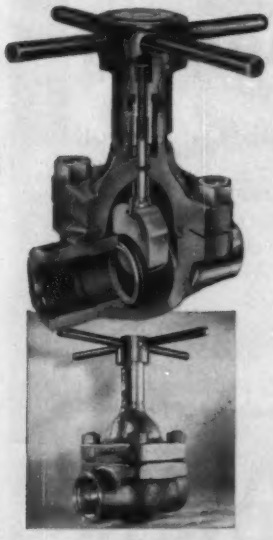
Valves for Super Critical Steam Studied Many Years at Edward



Two of the super-heater loops and control panel in the Edward laboratories.

Recent contracts to build super critical steam electric generating units re-emphasize the importance of a continuing research project started years ago in the Edward laboratories. For example, using specially designed super-heater steam loops, Edward engineers have been testing valves at steam pressures to 5000 psi and temperatures to 1300F for the past five years. Data has been compiled continuously on distortion of various valve parts, ease of operation, packing performance and durability, creep or swelling of valve bodies, maintenance procedures, and other aspects of valve behavior in the super critical (above 3206.2 psi Abs.) range. Such foresight into valve problems, plus the ability to incorporate knowledge gained through research into new designs, keeps Edward ahead of today's technological applications.

Abrasive Fluid Valve Developed by Edward for Oil Drilling Mudlines



Users report reductions in valve maintenance costs up to 80% on oil drilling mudlines that have been refitted with the new Rockwell-Built MUDWONDER abrasive fluid valve. Their enthusiastic acceptances again attest to the ability of Edward research and development engineers to find the facts and build their findings into a valve.

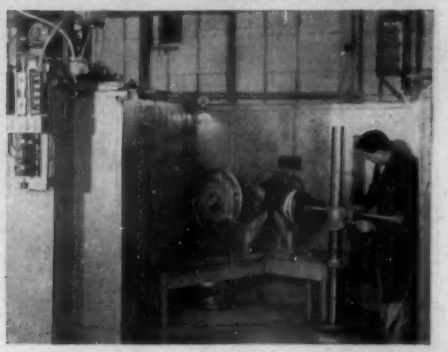
Erosion, corrosion, and the settling of solid materials which caused frequent shut-downs and numerous part replacements were some of the special problems brought to Edward early in 1948. MUDWONDER was the answer. Drilling rig operations in Oklahoma, Texas, and Louisiana have proved its superiority in controlling flow of drilling mud which often contains much sand, shale and corrosive clays.

If you have troublesome valve applications why not discuss them with Edward engineers? Their experience and facilities qualify them to solve difficult valve problems.

GLOBE AND ANGLE STOP • FEED-LINE • BLOW-OFF • NON-RETURN CHECK • GATE • GAGE AND INSTRUMENT • RELIEF • STRAINERS

Technical Tips

Judging Radiographs of Steel Castings



Above is new remotely controlled, pneumatically operated radiography apparatus designed by Edward engineers to improve the quality of radiographs and protect the operator from radiation.

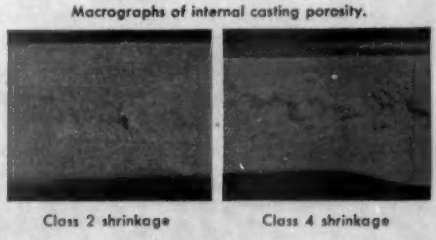
The ASTM Standard E71-47T sets up TENTATIVE INDUSTRIAL RADIOGRAPHIC STANDARDS FOR STEEL CASTINGS. The standards contain sample "x-ray type" films for seven types of steel casting defects including: (1) gas and blowholes, (2) sand spots and inclusions, (3) internal shrinkage, (4) hot tears, (5) cracks, (6) unfused chaplets and (7) internal chills. Each type of defect is described by three to six sample films which demonstrate different classes of soundness ranging through Class 5, the most severe.

Shrinkage defects are the ones most commonly developed by radiographic examination of steel valve castings. Comparing films for a particular casting under investigation with the ASTM standard films enables the engineer to determine the defect class. This standard, consequently, is a great aid in enabling all engineers to talk the same language when discussing radiographic soundness of castings.

A further comparison which is not given in the ASTM standard is the relation between a defect of any particular class with the actual cross-section of the casting. Shown below are etched cross-sections of two sample castings which show Class 2 and 4 shrinkage defects. An examination of these along with standard radiographic film helps an engineer to more clearly form a mental image of the defect he is considering.

Interpreting radiographs is aided by set standards but establishing the scope of the radiographic examination within practical and economic limits requires experience. A quarter century of perfecting techniques has given Edward casting experts this "know-how."

Macrographs of internal casting porosity.

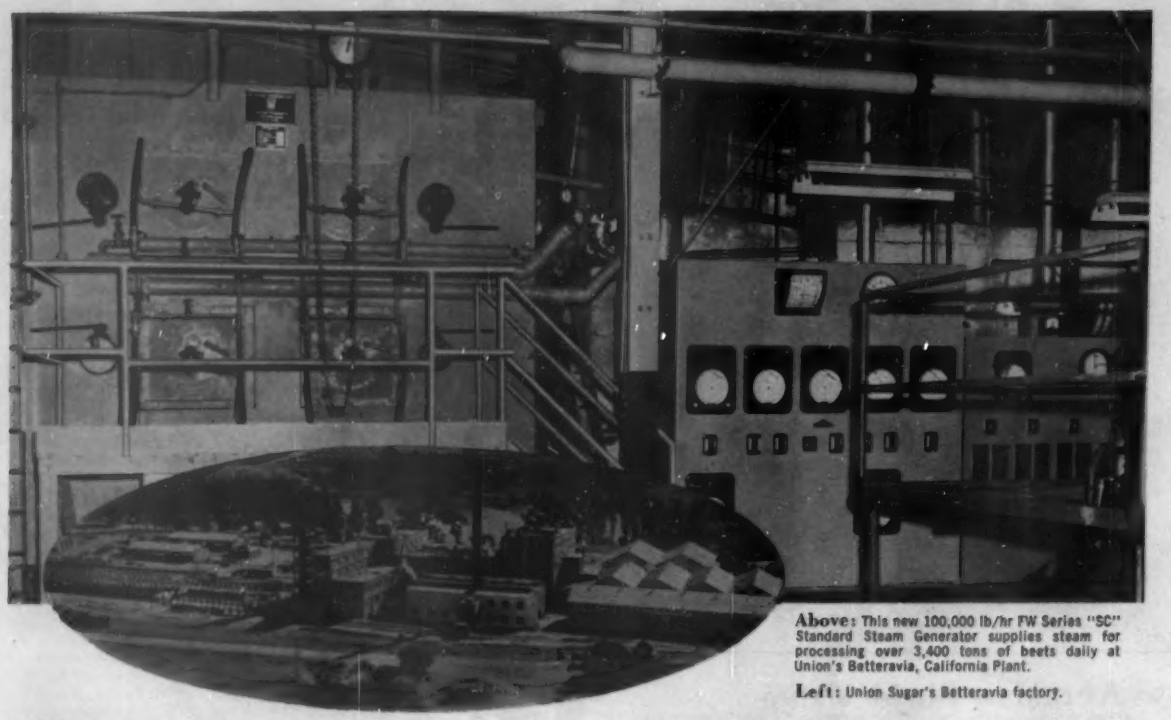


Class 2 shrinkage | Class 4 shrinkage

Edward Valves, Inc.
Subsidiary of
ROCKWELL MANUFACTURING COMPANY
EAST CHICAGO, INDIANA

Union Sugar

obtains low-cost steam



Above: This new 100,000 lb/hr FW Series "SC" Standard Steam Generator supplies steam for processing over 3,400 tons of beets daily at Union's Betteravia, California Plant.

Left: Union Sugar's Betteravia factory.

with a new

FW Series "SC" steam generator

This new Foster Wheeler "SC" Series Standard Steam Generator is a part of a continuing modernization and expansion program being carried on by the Union Sugar Division of Consolidated Foods Corporation, a pioneer California beet sugar company.

In selecting this unit, Union has taken advantage of the latest development by Foster Wheeler toward the reduction of industrial steam costs. This new generator embodies advanced design features which result in low installation, operating and maintenance expenses.

Maximum dependability under continuous full-load is assured by such advantages as: completely water-cooled furnace, fully drainable superheater, highly efficient boiler surface arrangement, and unrestricted circulation. The design also provides flexibility in heat recovery equipment, balanced or pressurized firing and steam purifying systems.

Fuels: Oil or gas—*Steam Temperatures:* Saturated to 950F—*Capacities:* 50,000 to 150,000 lb/hr—*Pressures:* to 1500 psi.

For complete information, write for Bulletin B 55-4, *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

For more data circle 512 on Post Card

POWELL VALVES . . . THE COMPLETE QUALITY LINE . . . POWELL VALVES

. . . THE COMPLETE QUALITY LINE . . . POWELL VALVES . . . THE COMPLETE QUALITY LINE . . .

. . . THE COMPLETE QUALITY LINE . . . POWELL VALVES . . . THE COMPLETE QUALITY LINE . . .

Preferred for Precision and Performance

FIG. 19384—900-Pound Steel Pressure Seal Non-Return Globe Valve, Gear Operated.

Powell Valves are the choice of engineers because they know every valve is precision made, meeting every specification—every time.

And there are other good reasons why engineers prefer Powell Valves—because Powell Valves are dependable . . . economical . . . and Powell has the COMPLETE quality line of valves.

Consult your Powell Valve distributor. If none is near you, we'll be pleased to tell you about our complete line, and help solve any flow control problem you may have.

The Wm. Powell Company
Cincinnati 22, Ohio... 109th year

"Visit our booth No. 191 at the Chicago Exposition of Power and Mechanical Engineering, November 14–18"

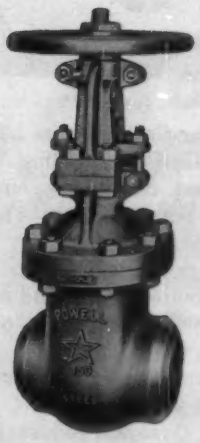


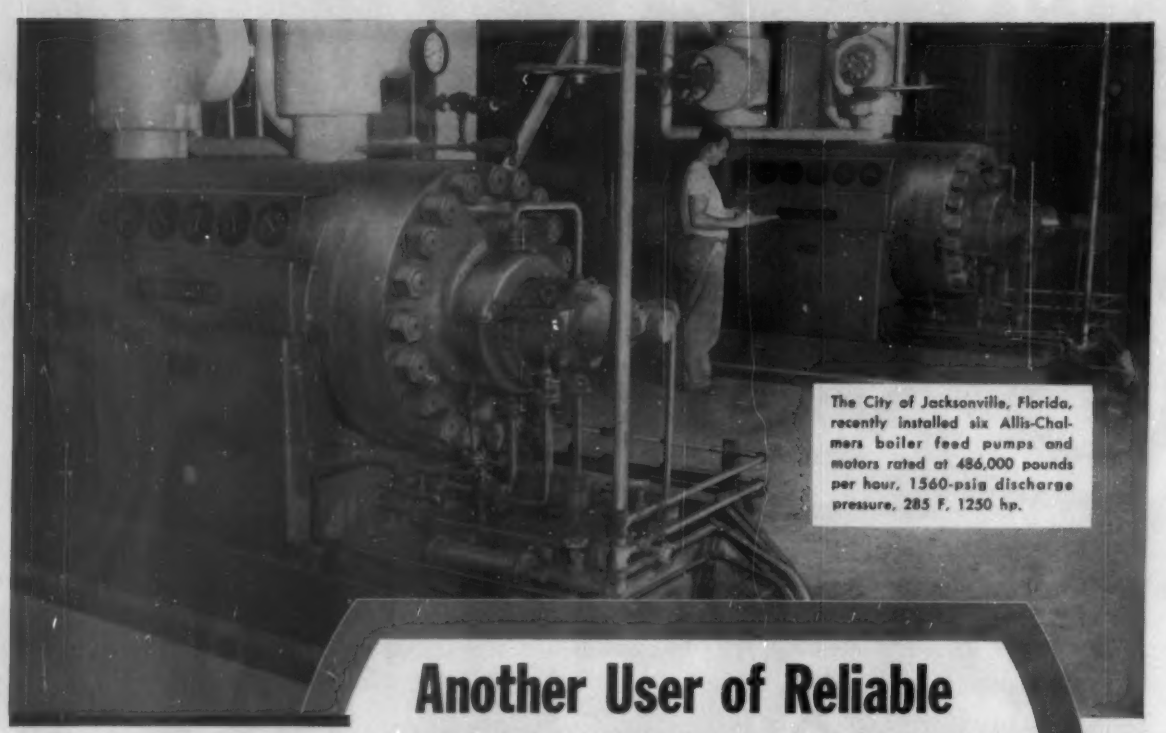
FIG. 1503WE—150-Pound Steel Gate Valve.

FIG. 11323—1500-Pound Motor Operated Steel Pressure Seal Gate Valve.

FIG. 19003—900-Pound Steel Pressure Seal Gate Valve.

POWELL VALVES

For more data circle 513 on Post Card



The City of Jacksonville, Florida, recently installed six Allis-Chalmers boiler feed pumps and motors rated at 486,000 pounds per hour, 1560-psig discharge pressure, 285 F, 1250 hp.

Another User of Reliable ALLIS-CHALMERS barrel-type PUMPS

City of Jacksonville

Here are the reasons for wide acceptance of these pumps:

- Outstanding performance — fully proved by service records.
- High efficiency and smooth operation under fluctuating loads — first stage has twin, single-suction impellers for low NPSH requirements.
- Simple maintenance—expansion joint and shaft seals are brought to outside of pump where they can be easily inspected.
- No balancing device needed—axial balance is maintained by back-to-back mounting of the impellers.

THERE are outstanding features like these throughout the Allis-Chalmers line. Whether you require boiler feed, condensate, circulating or other power plant pumps — it pays to standardize on Allis-Chalmers.

In addition, A-C can supply pumps, motors and control of coordinated design and manufacture. This means one responsibility — one guarantee of satisfaction.

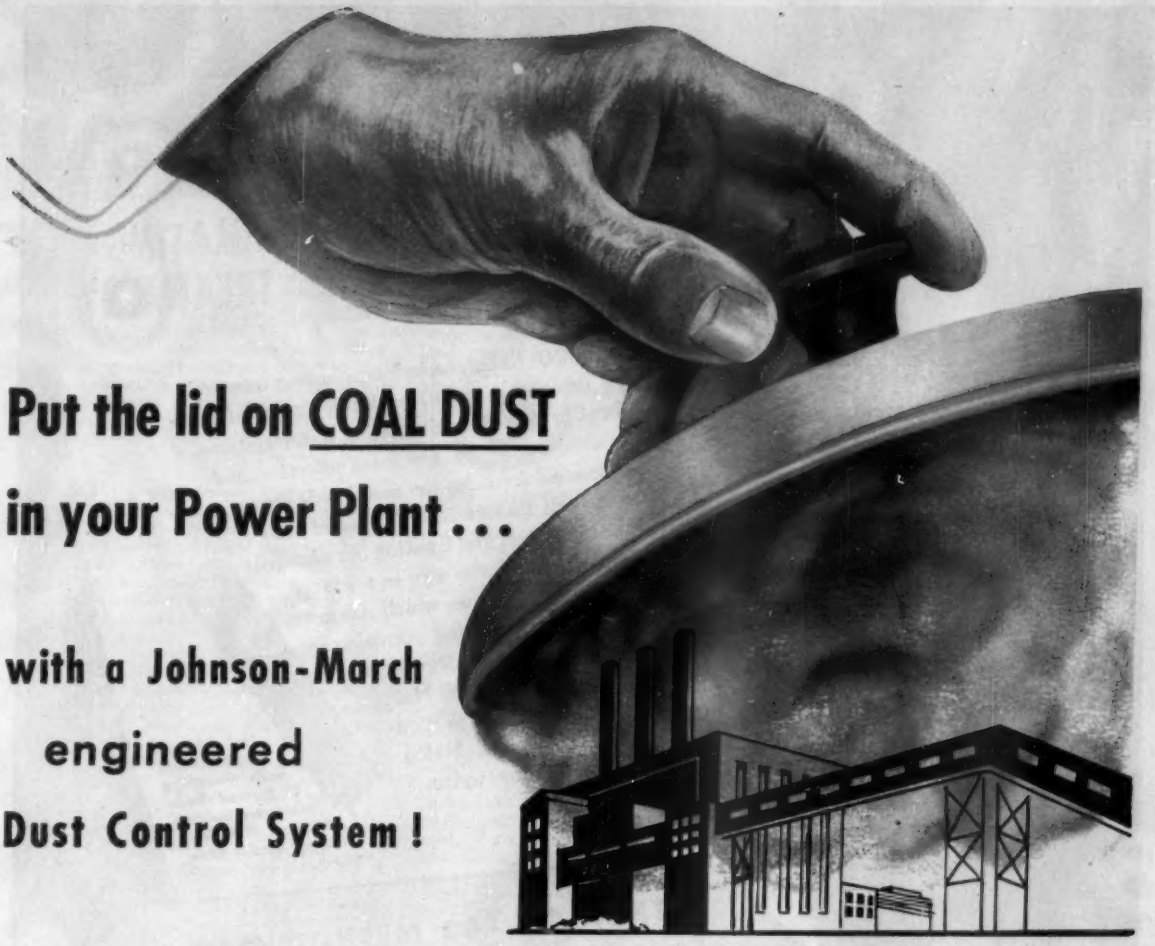
Get complete information on barrel-type boiler feed pumps. Call your nearby A-C office or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin for Bulletin 08B7899.

A-4854

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

For more data circle 514 on Post Card



Put the lid on COAL DUST in your Power Plant...

with a Johnson-March engineered Dust Control System!

Here's the simplest, most economical way you can stop dust in your power plant. A Johnson-March engineered dust control system stops coal dust wherever it occurs—at car dumpers, crushers, hoppers, belt galleries and coal piles . . . as well as dust created in fly ash handling and disposal.

Low-cost liquid dust control systems require almost no maintenance—cost only 1/10 as much as most other dust handling systems. No costly ducts, hoods or fans to interfere with normal operations.

Join the many leading power plants that have solved maintenance problems due to coal dust . . . fire and explosion hazards . . . community dust nuisance problems . . . safety hazards . . . with economical Johnson-March engineered dust control systems.

Even if you now have a mechanical dust collection system, let Johnson-March engineers show you how it can be improved at low cost. For a fast, sure solution to your plant and community dust problems, fill in and mail this coupon today.

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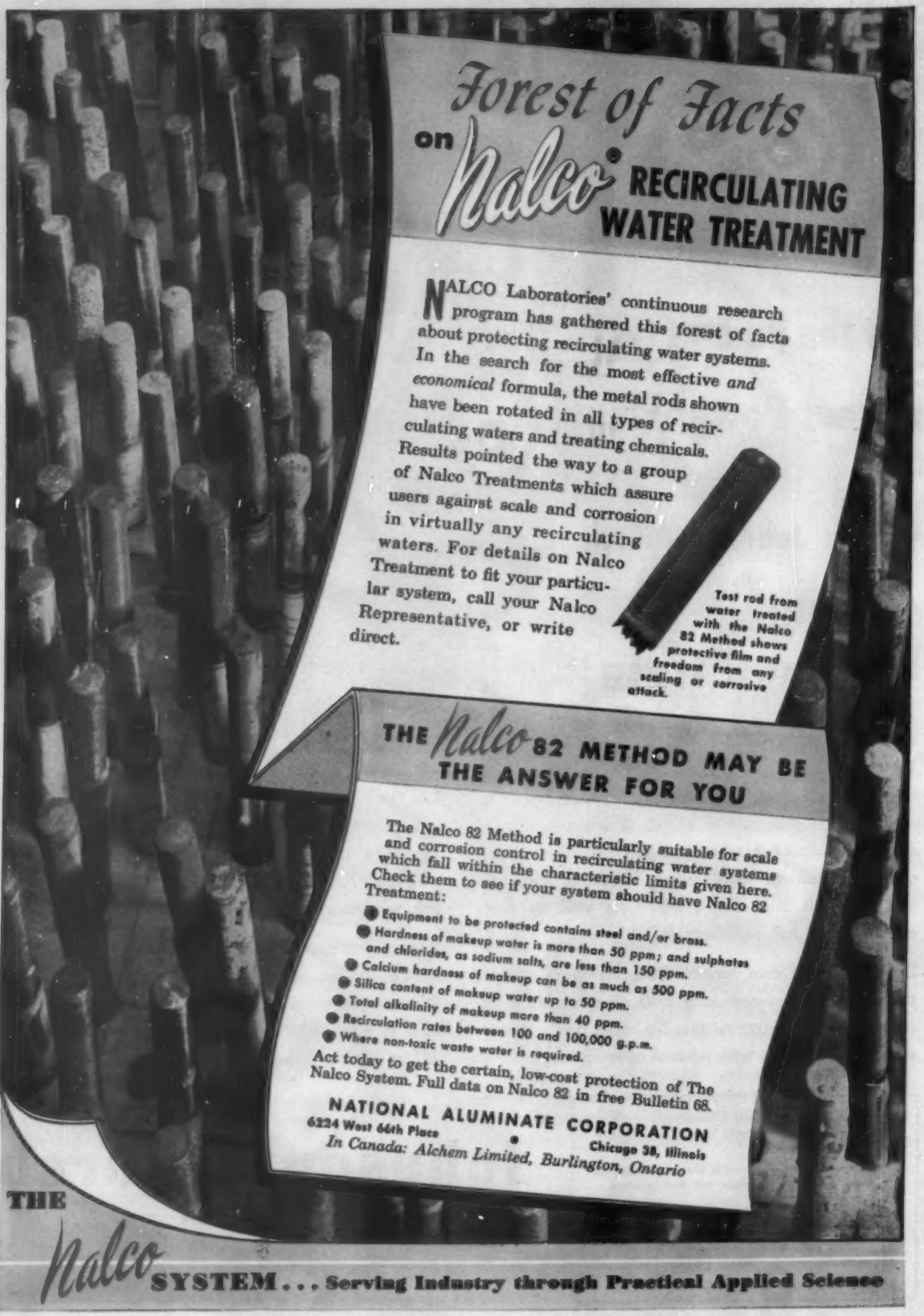

Forest of Facts on Nalco® RECIRCULATING WATER TREATMENT

NALCO Laboratories' continuous research program has gathered this forest of facts about protecting recirculating water systems. In the search for the most effective *and economical* formula, the metal rods shown have been rotated in all types of recirculating waters and treating chemicals. Results pointed the way to a group of Nalco Treatments which assure users against scale and corrosion in virtually any recirculating waters. For details on Nalco Treatment to fit your particular system, call your Nalco Representative, or write direct.

Test rod from water treated with the Nalco 82 Method shows protective film and freedom from any scaling or corrosive attack.

THE Nalco 82 METHOD MAY BE THE ANSWER FOR YOU

The Nalco 82 Method is particularly suitable for scale and corrosion control in recirculating water systems which fall within the characteristic limits given here. Check them to see if your system should have Nalco 82 Treatment:

- Equipment to be protected contains steel and/or brass.
- Hardness of makeup water is more than 50 ppm; and sulphates and chlorides, as sodium salts, are less than 150 ppm.
- Calcium hardness of makeup can be as much as 500 ppm.
- Silica content of makeup water up to 50 ppm.
- Total alkalinity of makeup more than 40 ppm.
- Recirculation rates between 100 and 100,000 g.p.m.
- Where non-toxic waste water is required.

Act today to get the certain, low-cost protection of The Nalco System. Full data on Nalco 82 in free Bulletin 68.

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HELPFUL BULLETINS

PUMPS, PUMPING

101 Controlled Volume Pump — Bulletin 955 describes latest addition to company's line of controlled volume pumps for low capacity flow control. Details operation of stroke length adjusting air servo system, and includes information on application, features and specifications. Diagrams are given showing major components, and detailing its application and hook-up in a typical pneumatic flow-control system. Milton Roy Co.

102 Proportioning Pump — Bulletin 1105-2 describes company's Model 1105 Adjust-O-Feeder designed for pumping petroleum, chemical and boiler feed water additives in accurate predetermined quantities. Contains a capacity table, typical applications with schematic diagrams, and lists chief advantages. Proportioneers, Inc.

103 Two-Stage Pumps — Bulletin 52B6105C describes two-stage pumps for boiler feed and other high pressure uses available in close-coupled and frame type construction in capacities to 300 gpm at heads of 300 to 550 ft at temperatures to 250 F. Dimensions and performance charts included. Allis-Chalmers Mfg. Co.

104 Condensation Return Units — Bulletin 113-HR describes company's Type HR Apco-Matic condensation return units for heating systems with E.D.R. ratings from 800 to 10,000 and pressures to 80 psi. Includes both the Simplex (single pump) and Duplex (twin pump) models. Explains advantages of vertical turbine type pump design, and gives dimensions, capacities, weights and condensed specifications. Aurora Pump Div., The New York Air Brake Co.

105 High Vacuum Pumps — Catalog 425, 52 pp, on high vacuum pumps, features both engineering and catalog sections. Profusely illustrated, the book contains installation photos, drawings, performance curves, conversion tables enabling its use as a vacuum engineering reference book. The catalog section of the book presents compound, single-stage simplex and duplex and two-stage mechanical booster high vacuum pumps. Text covers construction details, applications, operation, specifications. Treated in the engineering section are high and low absolute pressure requirements, selection factors, determination of pipe sizes, influence of condensable vapors, other technical aspects of vacuum pump engineering. Kinney Mfg. Div., New York Air Brake Co.

PIPING, VALVES, FITTINGS

106 Asbestos-Cement Pipe — Manufacturing methods in producing asbestos-cement pipe for water systems are described in this 8-pp bulletin, which points out savings in installation time and outlines characteristic advantages once the pipe is in the ground. Recommended procedures for installing pipe and assembling Ring-Tite coupling, as well as table of sizes and fittings are included. Johns-Manville.

107 Laminated Pipe — Bulletin FTL-1 on company's line of laminated fluorocarbon resin pipe describes physical and chemical properties, includes piping specifications, a detailed description of flanging and coupling pipe in the field with a special tool, as well as suggested applications for the chemically inert plastic pipe. Latest price list is inserted in bulletin. Resistoflex Corp.

108 Regulating Valves — Folio 4 describes briefly automatic valves for level and pressure control of steam, air, gas, oil and water. For operating conditions involving pressures to 600 psi and temperatures to 750 F. Float and lever valves, pump governors and pressure regulators are illustrated along with features and application suggestions. Schade Valve Mfg. Co.

109 General Purpose Valves — Gate, globe and angle valves in sizes ¼ through 2 in. are covered in 32-pp Supplement 1 to Catalog F-9. Major design and construction features of these general purpose valves are explained briefly and illustrated. Arranged for easy reference, catalog provides illustrations of each valve type, dimensions, materials of construction. Henry Vogt Machine Co.

110 Control Valve — Bulletin 966 describes company's pilot operated control valve which converts from pressure reducing and regulating to back pressure control by a simple switch of control lines. Information included covers materials available, pressure and temperature ratings, engineering drawing and details, capacity, performance and construction features. A. W. Cash Co.

111 Forged Steel Valves — Bulletin 551, 6-pp, covers company's small forged steel valves. Illustrates and gives details on forged steel stop, stop-check and needle valves for a variety of applications including steam power stations, boiler piping, petroleum installations, chemical and industrial plants. Edward Valves, Inc.

112 Water Valves — Manually operated water valves, 0 to 6000 psi, are cataloged in this illustrated bulletin. Ordering data and valve characteristics are given on standard, manifold porting and tandem mounting four-way types, manipulators and shut-offs. Barksdale Valves.

113 Union Bonnet Valves — Illustrated Form 1006 describes union bonnet bronze gate valves. Specifications, general dimensions, service and design details are provided. The Ohio Injector Co.

114 Rubber Lined Valves — This condensed bulletin deals with company's hard rubber lined gate and check valves for corrosive services. Contains tables giving range of sizes available and dimensions for both rubber lined gate valves and rubber lined horizontal swing check valves. Describes revolving double disc parallel seat gate valve principle. Darling Valve & Mfg. Co.

115 For Corrosive Service — Circular 592 describes and illustrates Causul metal gate valves for corrosive service. Dimension and application tables are provided and design details shown. The Lunkenheimer Co.

116 For High Pressures — Solenoid valves for heavy duty industrial use for pressures to 5000 psi at 150 F and 2500 psi at 450 F are cataloged in Bulletin HP 201. Gives sizes, materials of construction and operational information on direct lift and pilot operated units. Atkomatic Valve Co., Inc.

117 Seamless Welding Fittings — Alloy, carbon and stainless steel welding fittings are described in 6-pp Bulletin FB-500. Features are discussed briefly and grades and size ranges covered. Photos show fittings and flanges. Tubular Products Div., The Babcock & Wilcox Co.

118 High-Flow Coupling — Bulletin 230 outlines the advantages of company's quick-connect disconnect Hi-Flow Coupling. Discusses uses and construction, includes a fully-detailed cut-away of coupling, lists dimensions and gives ordering information. Snap-Tite, Inc.

VENTILATING, REFRIGERATION AND AIR CONDITIONING

120 Air Conditioning Systems — Text of a talk about air conditioning systems for multi-story buildings is reprinted in booklet form, Booklet RP-588, reviewing various types of air-circulation systems employed today, their method of operation, advantages and disadvantages. Line drawings, cut-away views and photos illustrate text. Worthington Corp.

121 Air Conditioning Equipment — Bulletin 4001 describes and illustrates company's line of special and standard air conditioning and refrigeration equipment. Descriptions of dry expansion Freon and storage coolers, condensers, and slug eliminator and balance loader are included. Photos and piping diagrams illustrate text. The Patterson-Kelley Co., Inc.

You'll save time in ordering bulletins by using the Reader Service Cards on page 117. Of course we honor letterhead requests—but it takes us somewhat longer to handle them.

122 Ventura Fans — Bulletin 7214 describes company's Model B and E Ventura fans for commercial and industrial ventilation. Discusses features of the V-belt driven fans and their application, and includes performance tables listing electrical power requirements, delivery ratings at different static pressures, fan speed, motor horsepower, nominal rotor diameter and net weight for each of the sizes in each line. American Blower Corp.

INSTRUMENTS AND CONTROLS

124 Proportional Control — Bulletin 4–11 describes company's line of elec-

tric proportional controllers used for control of dew point, pressure and temperature in batch process, combustion atmosphere and heat treating furnace applications. Explains functions of three types of electric control: proportional plus manual reset; proportional plus automatic reset; and proportional-set average-position. Details design advantages. The Foxboro Co.

125 Improved Controller — Bulletin F 5795-2 tells how the Capaciline, a supplementary control device "anticipates" fuel needs of controlled heating equipment and enforces straight line control on the process variable. A typical straight line temperature control application is sketched. Wheelco Instruments Div., Barber-Colman Co.

126 Pneumatic Flow Control — Bulletin 285-M30, 6-pp, describes flow and pressure control in water filtration and waste treatment plants, and in many industrial processes with a pneumatically actuated device weighing only 15 lb and 16 by 3 in. long. Bulletin contains dimensions and installation and schematic diagrams in addition to useful information on description, operation, and advantages. Builders-Providence, Inc.

127 Combustion Control — Regulators for automatic combustion control for oil, gas or coal fired boilers are presented in Bulletins E 102 and E 104. The former describes a self-contained regulator designed especially for combustion control of package boilers. Bulletin 104 describes and illustrates several regulatory instruments — a master regulator, loading transmitter, draft regulators, others. Reliance Instrument Mfg. Corp.

128 Pyrometer Service Tips — Bulletin F 7259, 12-pp, offers service tips for pyrometer users — including what to do if instrument is reading erratic . . . temperature curve off . . . reading too high . . . or too low . . . or instrument controls erratically. Barber-Colman Co.

129 Electronic Controls — Complete with illustrations and circuit diagrams, Bulletin EC-1, 16-pp, contains simplified, non-technical information on the installation, performance and maintenance of the basic Dynamatic electronic control. Principles used to accomplish stepless speed control of Dynamatic eddy-current rotating equipment are described, as well as precise speed control and other features. Dynamatic Div., Eaton Mfg. Co.

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the Reader Service Cards page 117. When ordering catalogs, allow time for us to relay your requests to the manufacturers—and for them to mail out copies. Remember, manufacturers are often swamped with catalog requests.

130 Dissolved Oxygen Analyzer — Bulletin 110-A describes the application of company's Model 2B2B dissolved oxygen analyzer to modern steam generating plant operations. Data covered includes basic principles of measurement, equipment required, flow diagrams and descriptions of typical sampling systems, and detail illustrations of the instrument and its features. Arnold O. Beckman, Inc.

ELECTRICAL, LIGHTING

131 Aluminum Bus Bars — The use of aluminum bus bars in both feeder and plug-in or trolley busway distribution systems is described in 8-pp Bulletin GEA-6169. Lists advantages in using aluminum as a conductor in busway applications, and includes construction features, operating characteristics, and specifications. General Electric Co.

132 Rerated Motors — Design and operation advantages of company's Series 100 totally-enclosed fan-cooled, open drip-proof, and explosion-proof motors, are outlined in 16-pp Bulletin N100R, illustrated in color. Large sectional views illustrate component parts and operation, and tables list dimensional data on ½ to 40 hp models. Stresses such advantages as smaller size, lighter weight, cooler performance, and attractive appearance. Howell Electric Motors Co.

133 On Step Regulator Ratings — A new approach to step regulator application as a possible solution to the load growth problem is contained in 6-pp Bulletin 21R8317, entitled "How To Increase Step Regulator Ratings." Shows how the losses of step regulators decrease as the tap changer moves closer to the neutral position and how it is possible to increase current ratings when operating on these taps. Allis-Chalmers Mfg. Co.

134 Enclosed Switches — Catalog 83, 28-pp, describes in detail the wide variety of enclosed switches which are designed for use on a-c or d-c industrial applications. Included are general purpose switches, sealed switches, heavy-duty limit switches, hand-operated switches and maintained-contact switches, all of which are available in a variety of actuator designs, contact arrangements and electrical ratings. Photos, dimensional drawings, circuit diagrams, electrical data are included. Micro Switch, Div., Minneapolis-Honeywell Regulator Co.

135 Electrical Insulations — This revised general catalog of flexible insulation materials is a compilation of technical data sheets. Products included are grouped in three categories: coated products, varnishes and plastic products. Also provided are many useful charts and conversion tables, purchasing information and a list of sales representatives in U. S. cities. Catalog comes in a loose-leaf binder so additional sheets may be added. Available to qualified power engineers, please state your job title when requesting this. Irvington Varnish & Insulator Div., Minnesota Mining & Mfg. Co.

136 High Current Testers — Data Sheet 4755 presents portable high current test instruments for checking, calibrating and coordinating reclosers, sectionalizers, other electrically actuated protective devices. Specifications cover the Multi-Amp's range of application with several makes of oil circuit reclosers and describe its component equipment. A recommended procedure for periodic recloser maintenance care is included. Multi-Amp Corp.

137 For Emergency Lighting — Diagrams, charts and specifications useful in planning emergency lighting installations are contained in this 8-pp catalog, Form 5736, describing company's Lightguards — battery-powered emergency lighting equipment. Models designed for permanent connection, auxiliary lighting equipment (plug-in type) and a transparent plastic-cased battery are covered. Lightguard Models M, T, ME, and TE, together with type 3-COE-7 emergency lighting battery used in meeting rooms, passageways, institutions, stores, control centers are described. Exide Industrial Div., The Electric Storage Battery Co.

. . . Outstanding Among This Month's Catalogs

138 Power Plant Instruments — Publication 55-605-83 24-pp, presents well-organized data on manufacturer's line of boiler plant instruments and control systems. Generously illustrated with photos and schematic drawings, booklet describes combustion guides; draft gages; flow, level, temperature and pressure instruments; combustion control systems; and panels. Instrumentation installations at eight plants are charted as to problems involved and results. The Hays Corp.

139 Drive Selection Tables — Trx-Book 20P40, 74-pp, carries handy multi-color tables for quick and easy selection of constant speed Texrope V-belt drives. In addition to providing selection tables for belts, handbook furnishes information on design features, basic drive principles and technical data on sheaves as well as helpful hints for economical, safe and dependable operation of V-belt drives. Allis-Chalmers Mfg. Co.

140 Expansion Joints — Catalog 52, 36-pp, presents descriptive information and technical data on company's line of bellows type expansion joints and pressurized Hydropads. Gives details of construction, specifications, and general application data for standard Magnilastic expansion joints in various piping systems, as well as information on pressurized Hydropad for controlling pipe line surge. Text is supplemented with numerous photos, as well as diagrams, tables and charts. Cook Electric Co.

MECHANICAL POWER TRANSMISSION

142 Variable Speed Drives — Applications and advantages of company's Speed-Trol variable speed transmissions are described in this 8-pp illustrated bulletin. Discusses inner workings of the positive pulley design, as well as factors in drive selection, and includes a description of automatic and remote speed control accessories available. Sterling Electric Motors, Inc.

143 Gear Manual — Complete engineering data on company's line of gears and gear products is presented in 76-pp Catalog G-655. Illustrations, diagrams, definitions, tables, charts and explanations regarding all types are included, as well as a simplified method of calculating horsepower ratings. Photos and drawings illustrate design and operation features, specifications list technical data such as dimensions, capacities, standard ratios, efficien-

Unibestos lets steam pack more power

When high-pressure steam lines are protected with Unibestos, less heat escapes . . . more live steam is available for efficient power production.

Made of Amosite, Unibestos has strong, interlacing fibers that provide superior insulating protection with only *single-layer construction.* Easy to install, Unibestos is tough, durable insulation that withstands vibration . . . doesn't shatter even under extraordinary impact . . . inhibits corrosion. Built to last, it can be used over and over again without impairing its unmatched insulating properties. Unibestos® pipe insulation is available in sectional form through 44" O.D.

Write for **Free** descriptive Bulletin 109C.

UNARCO

Joe Bestos says:

. . . Remember, single-layer Unibestos locks in more heat than most *double-layer* insulations!

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NEW
Arnold O. Beckman
MODEL F3
OXYGEN ANALYZER

with the meter on the door

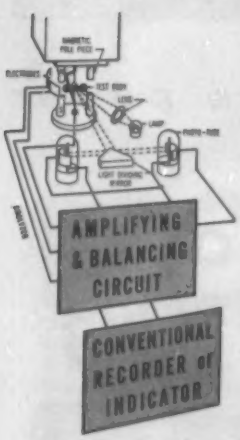
New convenience has been built into the well-known F3 Oxygen Analyzer . . . a meter on the door provides readings at the sampling point for making calibration checks, process changes, etc. In fact, complete analyzing, calibrating and indicating components are now incorporated into the single F3 unit—at no extra cost!

Use The Model F3

ON OPERATIONS LIKE THESE . . . TO MAKE SAVINGS LIKE THESE

COMBUSTION Boilers, Kilns, Direct-Fired Heaters, Stills, etc.	*Higher combustion efficiencies, at lower fuel costs*
PROCESSING Air Liquifraction . . . Processing Butadiene, Acetylene and Similar Gases	*Better product quality with minimum oxygen or air contamination*
PLANT SAFETY Hydrogenation, Hydrofining, Gas Compressors, Sulfur Grinding, etc.	*Control explosive atmospheres, reduce fire risks, minimize plant and personnel hazards*

Unique Operating Principle



The various applications highlighted above are only a few of the many ways Arnold O. Beckman Oxygen Analyzers—industry's great new profit builders—are being used by progressive operators to boost profits, cut costs.

These are the *only* oxygen analyzers that *continuously* measure process streams by an advanced magnetic principle that provides *direct physical measurement of the oxygen itself*—not of some secondary relationship.

Heart of the unit, as illustrated, is a dumbbell-shaped test body suspended in a magnetic field. Sample gas surrounding this test body causes it to rotate in the field, depending upon the oxygen content of the gas. The movement of a light beam, reflected by a small mirror on the test body, is measured by simple electronic circuits . . . and the result indicated directly on a conventional recorder or indicator. It's simple, positive, accurate!

No chemicals—filaments—catalysts cams—complicated mechanical parts!

Send for Helpful Free Literature *which describes this unique operating principle in detail—explains its many advantages and applications. When writing, outline your particular operations—we'll gladly supply specific information.*

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FEATURES OF THE F3

Many Ranges: Full scale ranges of 0-5%, 0-10%, 0-15% O_2 and higher.

Accuracy: 1% of full scale.

Multi-Ranges: Any instrument may be supplied with two or more ranges.

***Note:** For ranges narrower than 0-5% O_2 ask about the Model G2.*

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cies. Among the types covered are spur gearing, helical gearing, herringbone gearing, spiral gearing, worm gearing, spiral bevel gearing, zerol gears, sprockets, splines and others. Philadelphia Gear Works, Inc.

HEATERS, HEATING

145 On Hot Water Heating — This 8-pp semi-technical bulletin, 923, spells out the nature of problems involved in "big swing" hot water loads — such as encountered in commercial laundries — and explains why many storage type systems are inherently unable to solve these problems. Bulletin concludes with a discussion of the Iso-Therm as a solution to the problems of large scale hot water heating. Fuel savings and other advantages are also discussed. Fred H. Schaub Engineering Co.

146 Electric Heaters — Electric heating equipment for plants in which oils or process liquids are heated is described in Bulletin 102.1. Explains distinctive features of design and points out services to which these heaters can be advantageously applied. Exterior and skeletonized views and constituent elements are illustrated, and typical flow diagrams showing their application to a hot oil system for jacketed vessels and for an asphalt plant are included, as well as specifications. Hynes Electric Heating Div., Turbine Equipment Co.

147 Electric Heating Elements — Special advantages of electric heat and its typical applications are stressed in 28-pp illustrated Catalog EC-53. Helpful data on selection and use of electric heat are provided, also engineering data pertaining to commonly used solids, liquids, and gases and vapors. Tubular heaters, water immersion heaters, oil immersion heaters, strip heaters, custom made units and others are described and dimensional data given. A price list is included. Cutler-Hammer, Inc.

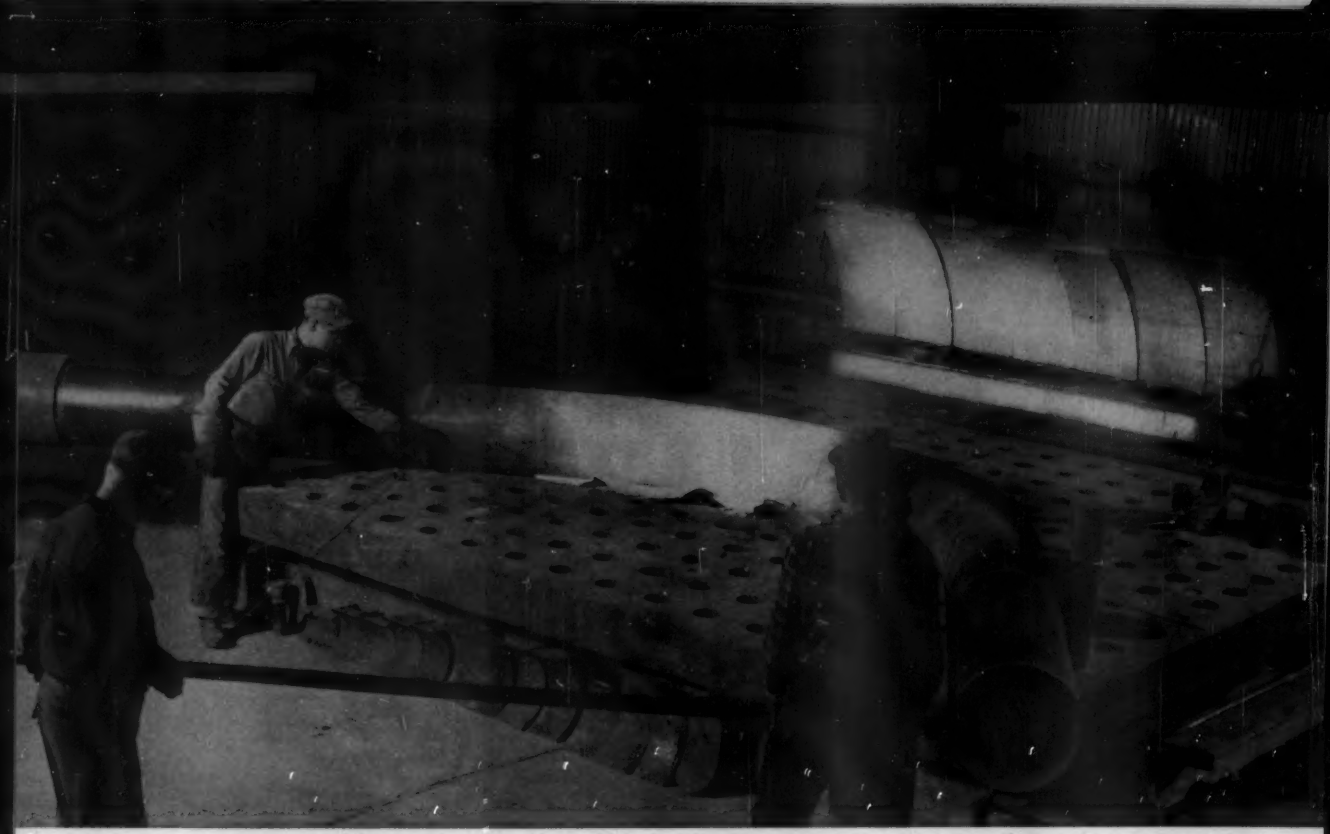
148 Cartridge Heaters — Construction advantages offered by this company's Chromalox electric cartridge heaters are illustrated and explained in Bulletin 815. Features affording increased lead wire protection are stressed. Several styles are shown along with data on sizes and ranges. Edwin L. Wiegand Co.

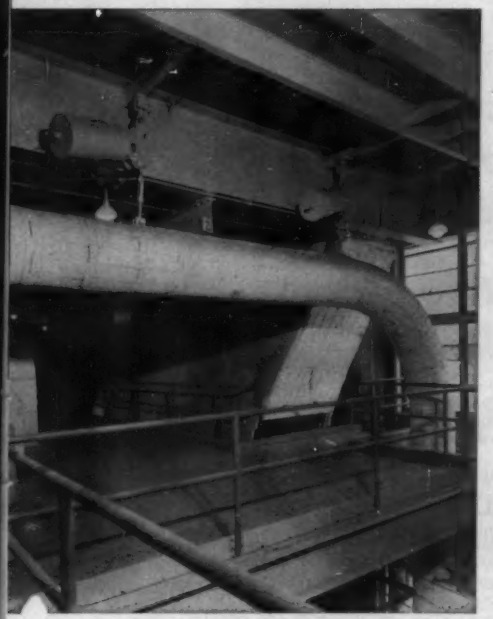
149 Specialized Heat Equipment — Six-pp Bulletin 108 outlining company's products and services contains detailed diagrams and drawings together with photos of some of its equipment in use. Describes some possibilities that exist in applying high velocity techniques and shows how problems may be solved with this combustion technology. Thermal Research & Engineering Corp.

150 Heat Transfer Surface — Bulletin 850 offers design and application data on Inner-Fin, the company's heat transfer surface described as a basic new concept in heat transfer engineering. Contains engineering data and general application information on the surface — applicable wherever any type of heat exchange is required. Bush Mfg. Co.

METALS

151 Nickel Austenitic Ductile Iron — Ductile Ni-Resist iron, a new engineering material combining strength and ductility of ductile cast iron with the resistance to corrosion, heat and metal-to-metal





This station, having an initial capability of 276,000 kw, was designed and erection supervised by Gilbert Associates, Inc., Reading, Pennsylvania. It is one of the most efficient and low-cost stations in the country.

At the new Shawville Station of Pennsylvania Electric Co.

it's NAVCO Piping throughout

Over 37 miles of pipe were installed by Navco in this highly efficient reheat station and all necessary prefabricated assemblies, in excess of 2,000,000 lbs., were produced in Navco shops. For field welding only, more than 15 tons of electrodes were used.

The photo above shows one of the bends required for the Main Steam. It is 16″ O.D. forged and bored with a wall thickness of 3.084″ and weighs 5½ tons. Material is ASTM A-335 P-22—2¼% Chrome. Operating conditions are 1850 psi at 1050°F. initial, with 1000°F. reheat.

The photo at the left shows this bend in service supported by dependable Navco Counterpoise Hangers.

In the past three years alone, Navco Piping has been installed in Central Stations generating in excess of 4,000,000 kw.

Next time you have a Piping job requiring reliability in performance and careful attention to every small detail, Navco will welcome the opportunity of quoting you.

Call, wire or write today!

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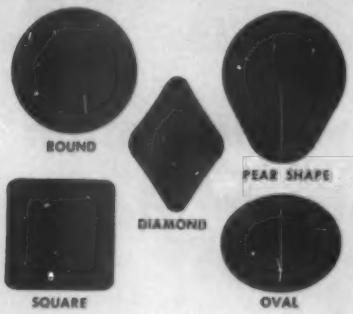
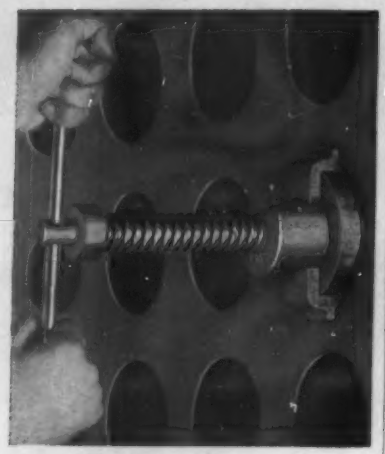
ROTO *Hand Hole* Seat Scraper

Eliminates Dirty, Tedious Work

Here is a simple, hand-operated tool for cleaning inside caps on boilers that will pay for itself many times over. This tool is equipped with retractable knives mounted on a revolving spindle having a bearing within a substantial yoke. An adjustable spring automatically maintains tension on the knives, sufficient to remove all foreign matter but not enough to cut the metal. A few turns to the right, and the job is done. A half turn to the left releases the tool. Try a Roto Seat Scraper and you'll wonder how you ever got along without one.

These are some of the hand hole shapes cleaned with a Roto Seat Scraper. Various sizes available.





Illustrating ease of operation of Roto Hand-hole Seat Scraper.

Roto Hand-hole Seat Scraper for B & W Boiler.

What Users Say—

It did a fine job. Completed the work in 80% less time.
(Engineer, Chemical Plant)

Roto Seat Scraper has paid for itself many times over on our Keeler Boiler.
(Supt., Public Utility)

One man cleaned inside cap seats on boiler header in 4 hours. Formerly took 2 men 3 days.
(Pennsylvania Manufacturer)

We also make a Reseating Machine for cleaning outside caps to assure a smooth, true fit. Send for details.

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wear possessed by conventional Ni-Resist castings is the subject of this bulletin. Compares properties of conventional and ductile Ni-Resist irons and summarizes present and potential industrial applications. The International Nickel Co., Inc.

152 Specialty Steels — This 32-pp illustrated guide to specialty steels defines characteristics of a broad range of special purpose steels in terms of end use. Briefly summarizes company's specialty product line, covering tool and die steels; stainless steels; silicon and high nickel electrical alloys; special purpose alloy steels; valve, heat-resisting and super alloy steels, tubing and pipe in various analyses and fine wire specialties. The Carpenter Steel Co.

COOLING TOWERS

153 Cooling Tower Maintenance — This bulletin on maintenance of redwood cooling towers includes a brief discussion on characteristics of redwood which favor its use in cooling tower construction. Maintenance information covers action of chemicals, bacteria, fungi, algae and mechanical erosion on the towers, and deals briefly with cleaning of tower and water treating. California Redwood Ass'n.

154 Redwood Lumber Grades — Bulletin STD 101 provides data on CTI grades of redwood lumber for structural applications in water cooling towers of the mechanical draft, industrial type. Details specifications for three grades and modifications. Cooling Tower Institute.

CORROSION CONTROL

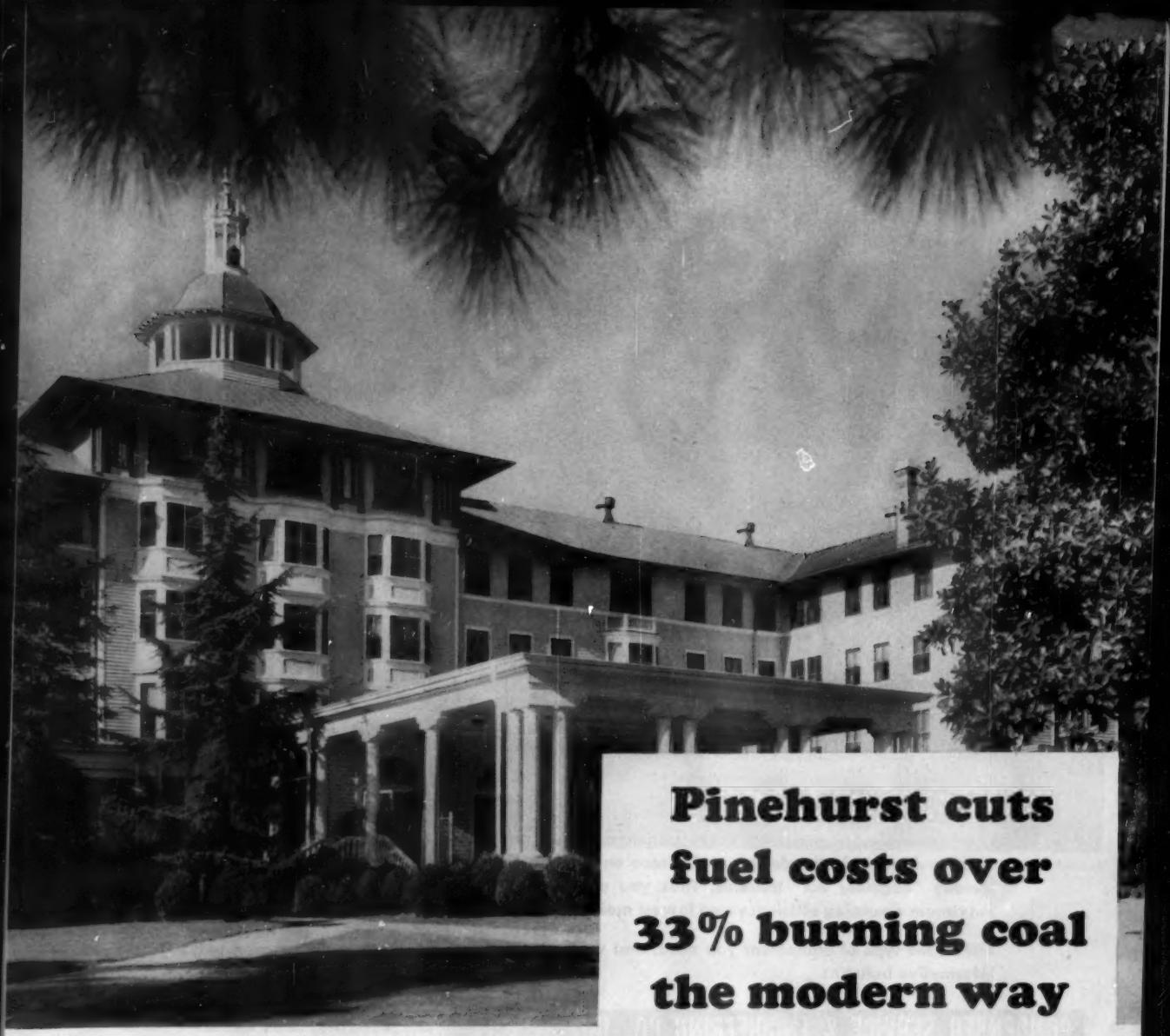
156 Sprayed Metal Coatings — Contamination and corrosion protection through the use of sprayed metal coatings is described in this illustrated bulletin. Gives data on application to processing equipment etc. Also discusses combination of vinyls, furans, phenolics, epoxys, silicones, neoprenes and chlorinated rubber with sprayed metal to provide corrosion protection for tanks, refrigeration equipment, underground conduits and fabricated steel. MW Protective Coatings Div., Metalweld, Inc.

157 For Corrosion Protection — How to get greater coverage from protective coating at lower costs in safeguarding pipe, pipe joints, fittings and couplings is described in this illustrated brochure. Covers the story of Tapecoat-X, a coal tar coating in tape form which is made with an extra thickness of coal tar to provide double-wrap protection from single-wrap application. The Tapecoat Co.

158 Corrosion Control — Treatment of industrial equipment to control corrosion cannot be a hit-and-miss proposition, cautions this 6-pp folder. Examples are given of optimum control measures that may avoid costly, unsound treatment procedures, including minor physical or operating changes. Hall Laboratories, Inc.

OTHER EQUIPMENT

159 Piping Insulation — Foamglas — a cellular stay-dry insulation for piping and equipment — is the subject of this 8-pp bulletin, FI-103. Presents physical properties; sizes and shapes available; and suggested thicknesses required for temperatures ranging from −50 to 800 F. Recommended specifications and photos of applications complete the booklet. Pittsburgh Corning Corp.



Pinehurst cuts fuel costs over 33% burning coal the modern way

The central power plant at the famous golfing resort of Pinehurst, N.C., has to furnish a reliable supply of steam to three hotels and seven other buildings. When Pinehurst recently decided to modernize power facilities, the consulting firm of Wiley and Wilson, Richmond, Va., was called in to study the situation. Since coal cost approximately 40% less than the next cheapest fuel, the final decision called for burning coal the modern way. Today two new automatic stoker-fired boilers (only one of which is operated at a time) replace four 150-hp hand-fired boilers. Combustion control is automatic; coal and ash handling is greatly simplified. And now, according to management, "the cost of generating steam is 33.4% less than with the old plant." For further information or additional case histories showing how other plants have saved money burning coal, write to the address below.

NATIONAL COAL ASSOCIATION
Southern Building, Washington 5, D. C.

Consult an engineering firm

Designing and building hundreds of heating and power installations a year, qualified engineering firms can bring you the latest knowledge of fuel costs and equipment. If you are planning the construction of new heating or power facilities—or the remodeling of an existing installation—one of these concerns will work closely with your own engineering department to effect substantial savings not only in efficiency but in fuel economy over the years.

facts you should know about coal

In most industrial areas, bituminous coal is the lowest-cost fuel available. • Up-to-date coal burning equipment can give you 10% to 40% more steam per dollar. • Automatic coal and ash handling systems can cut your labor cost to a minimum. Coal is the safest fuel to store and use. • No smoke or dust problems when coal is burned with modern equipment. • Between America's vast coal reserves and mechanized coal production methods, you can count on coal being plentiful and its price remaining stable.

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Three vertical type, full floating head Conseco Hot Water Converters.

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Conseco engineers profit by the experience of our maintenance division in the design of Conseco equipment. They literally "engineer out" troubles. Thus you are assured of maximum operating efficiency and lowest maintenance cost.

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160 Motor Scraper — Engineering, design, construction and mechanical features of company's TS-360 Motor Scraper are outlined in 8-pp Catalog MS-663. Photos and drawings point out advances incorporated in this 20 cu yd heaped or 15 cu yd struck capacity motor scraper powered by a 280 hp diesel engine. Specifications given. Allis-Chalmers Mfg. Co.

161 Temperature Measurement — A new edition of this popular 8-pp booklet on how temperatures are measured is now available. Defines temperature and discusses development of temperature scales. Temperature effects are listed; and brief chapters are devoted to temperature measurement by thermometers and pyrometers, by color, chemical signal. Tempil Corp.

162 Machinery Mountings — How Finnflex "floating pillow" vibration mountings provide improved vibration, shock and overload control for medium and heavy machinery is told in 4-pp Catalog FP-55. Details construction of the mountings and includes load capacities and frequencies and illustrations of typical installations. T. R. Finn Co., Inc.

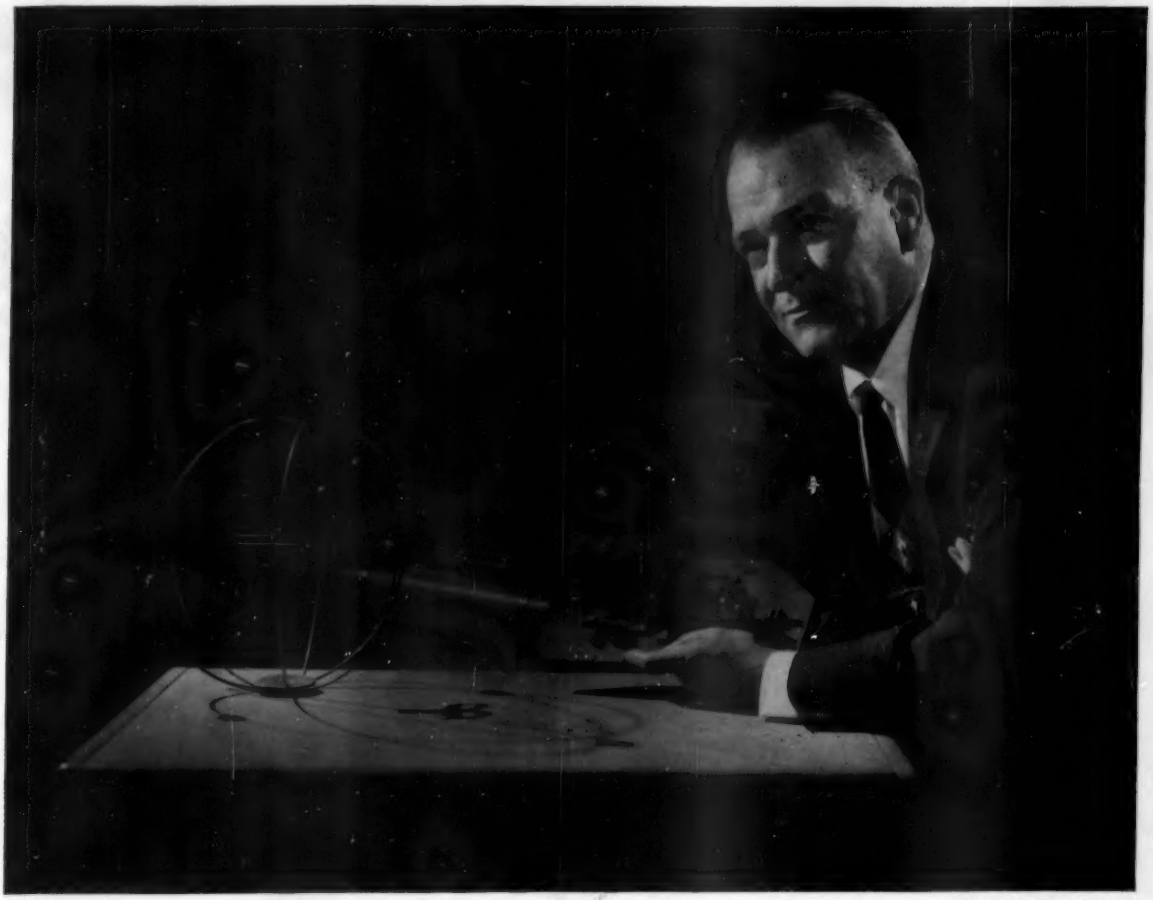
163 Rubber Parts — Complete data on rubber insulated parts such as clips, clamps, and grommets, and form dipped rubber parts is available in this informative chart. Contains detailed illustrations of parts, showing diagrammed applications, and outlines industries in which they are used. Includes tables indicating die sizes and available standard design. Automotive Rubber Co., Inc.

164 Industrial Rubber Products — Specifications and descriptions of 68 rubber hoses for every industrial use are presented in 8-pp Form 3765-R. In addition, bulletin contains data on 9 types of conveyor belts, seven types of flat power transmission belting, multiple and fractional horsepower V-belts, chute lining, rubber sheet packing and industrial friction materials. Cutaways show hose, coupling and belt construction. Thermoid Co.

165 Conveyor Belting — Proper selection and maintenance of conveyor belting is graphically portrayed in this 23-by-33 in. wall chart, listing 12 practical tips for getting more life out of belts. Covers storage of belts, correct design of loading chutes, use of automatic switches, lubrication, inspection. Chart also lists types of belt recommended for various uses, such as mining, metal processing, food processing, chemicals and coal handling in public utility plants. Hewitt-Robins, Inc.

166 For Better Masonry — Advantages of a mortar cement affording superior mortar characteristics and performance are outlined in this 24-pp bulletin. Quality control methods used to achieve and maintain uniformly high product performance are illustrated. Recommended practice covering materials, proportioning, mixing, laying of units and reference tables are included. Universal Atlas Cement Co.

167 Ion Exchange Primer — "Ion Exchange with Amberlite Resins," 28 pp, revised edition, defines ion exchange and discusses some fundamental ion exchange processes. A chapter on uses of ion exchange details its application in water conditioning, removal of metal iron contaminants, recovery of metallic ions, deacidification of solutions, deionization, catalysis by acids and bases, others. Included is a glossary of ion exchange terms. Rohm & Haas Co.



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Portrait by Fabian Bachrach

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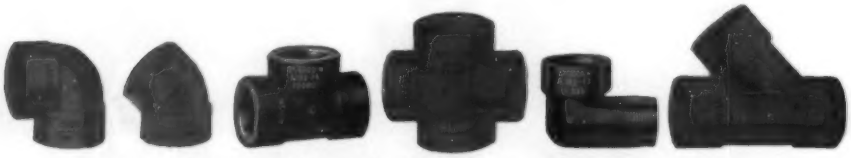

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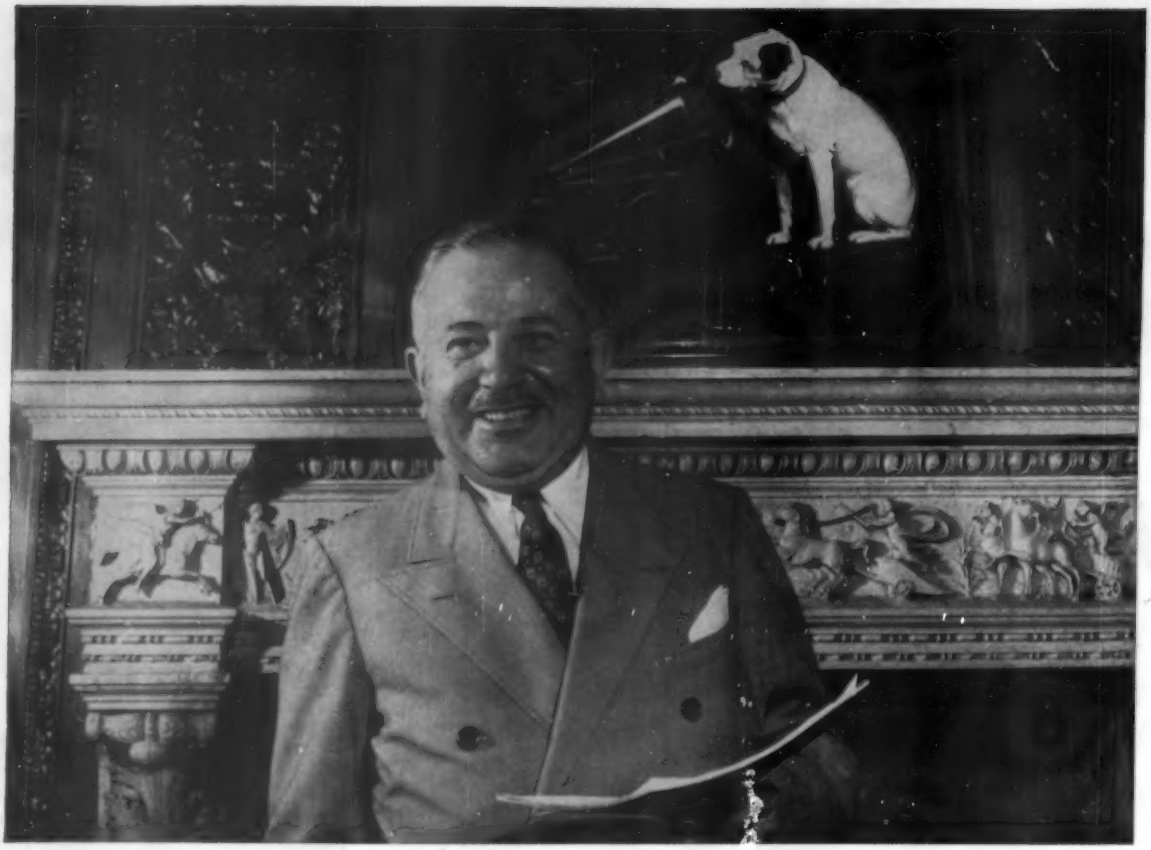

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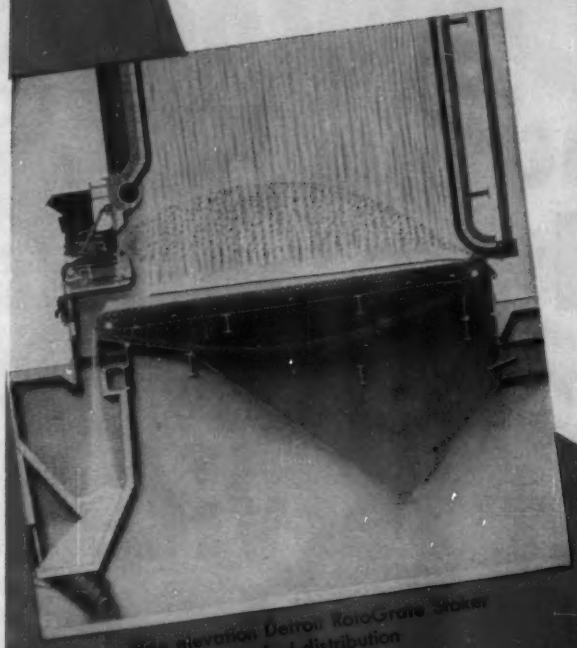
at Moundsville to Burn West Virginia Coal

Detroit RotoGrate is a modern spreader stoker with grates that move slowly forward, discharging ash at the front. It will burn any type of Bituminous coal or Lignite and many types of combustible refuse with high efficiency. Handles rapidly fluctuating loads. Produces more capacity per square foot of grate area. Precise control of fuel feed with grate speed and air supply provides smokeless operation.

There is a size and type of Detroit Stoker for every industrial need.

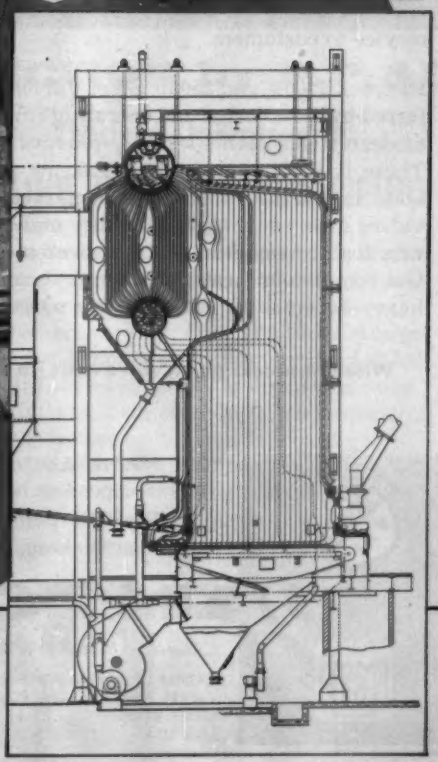


Side elevation Detroit RotoGrate Stoker shows uniform fuel distribution and continuous cleaning feature.

Moundsville, West Virginia, (Marshall County) Plant, Solvay Process Division, Allied Chemical & Dye Corporation.

Ask for latest Bulletins.

Detroit RotoGrate Stoker with Babcock and Wilcox two drum Striking boilers in Moundsville Plant



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Put an end to the costly hazards of valve leakage in your high-pressure, high-temperature steam plant! Let proved-in-the-line Hancock 1500# and 2500# Valves assure the safe, reliable performance so essential to protect personnel, plant and service to customers.

Hancock 1500# and 2500# Steel Valves are preferred by most design and operating engineers in modern steam plants for very practical reasons. There is no bonnet joint to leak, no gasket to leak, no seat insert to leak! In fact, these rugged valves have every design, quality and construction feature essential for the severest services. Get complete information, then try one of these heavy-duty valves. You will soon agree that . . .

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Shop fabricated assemblies above are produced to sizes which installation and shipping facilities permit.

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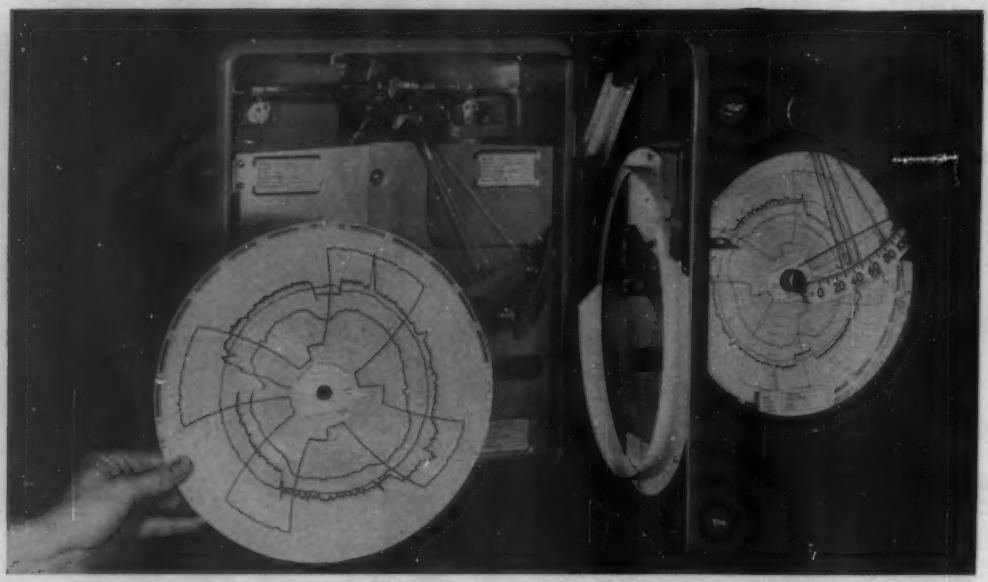

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Write for Product Specification E12-5 and actual chart sample. P20-1

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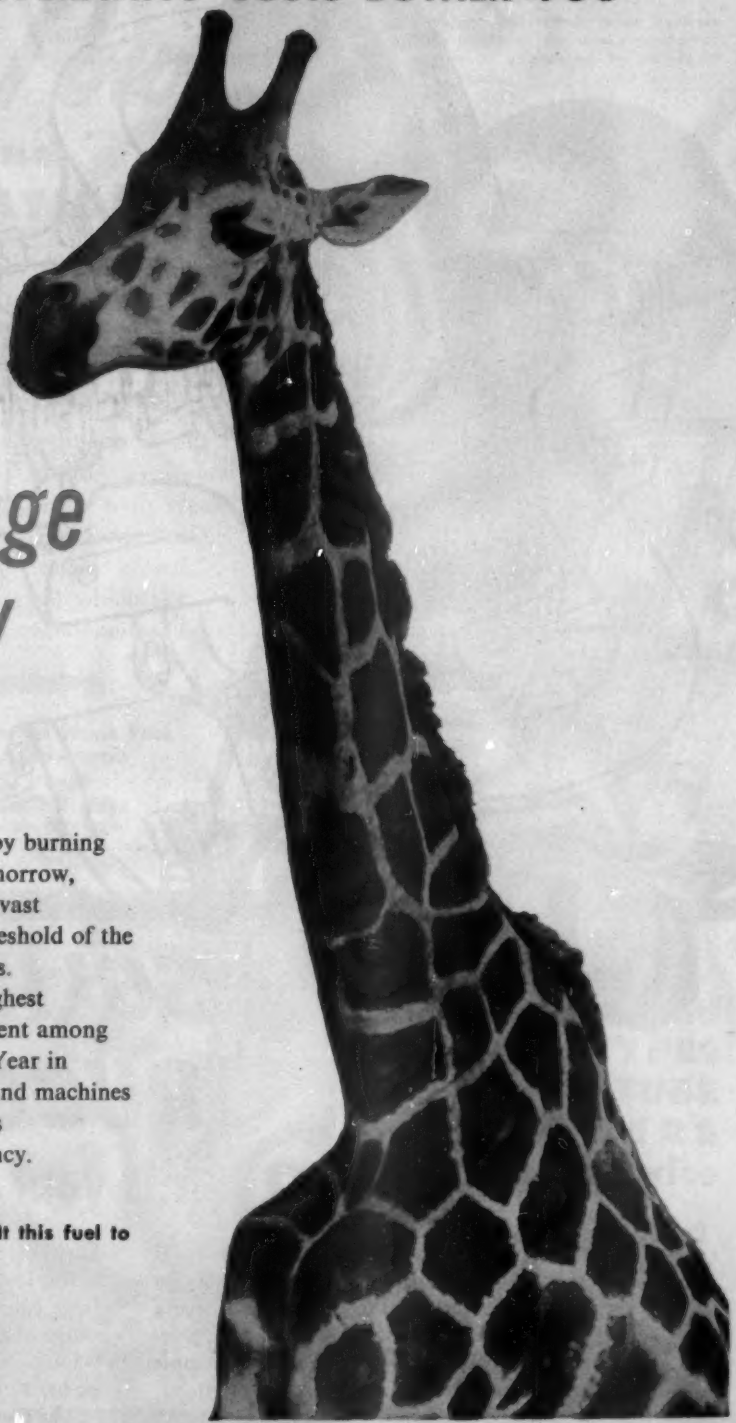

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BITUMINOUS COALS FOR EVERY PURPOSE

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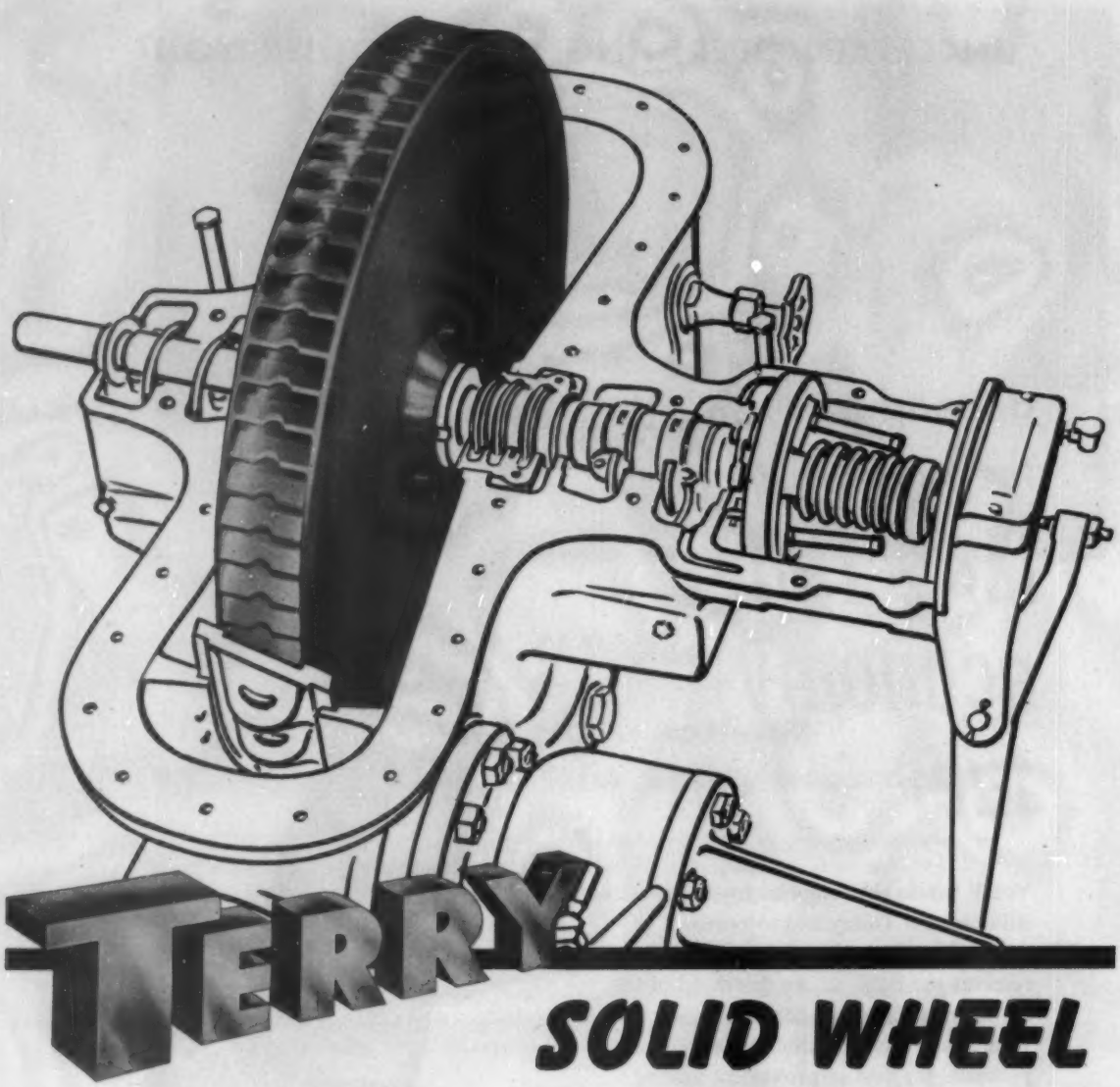

SOLID WHEEL RUGGEDNESS

is your turbine dividend

The rugged construction and fool-proof design of a Terry solid-wheel turbine can save you money by keeping maintenance costs to a minimum. Usually only taken down for routine inspection, any repairs that must be made are of relatively simple nature, and cost of replacement parts is small.

The rotor of the turbine is a single forging of special composition steel, in which a series of semi-circular buckets is milled. There are no separate parts to loosen or work out. As the only function of the blades is to form a series of pockets, any wear which might occur would not materially affect horsepower or efficiency.

It is impossible for the blades to foul. They have large clearances and are further protected by the projecting rims of the sides of the wheel. As the side clearances are also very large, end play can do no harm.

The Terry solid-wheel turbine is an extremely reliable piece of equipment—why not write for complete details today? Ask for a copy of Bulletin S-116.

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD 1, CONN.

TT-1198

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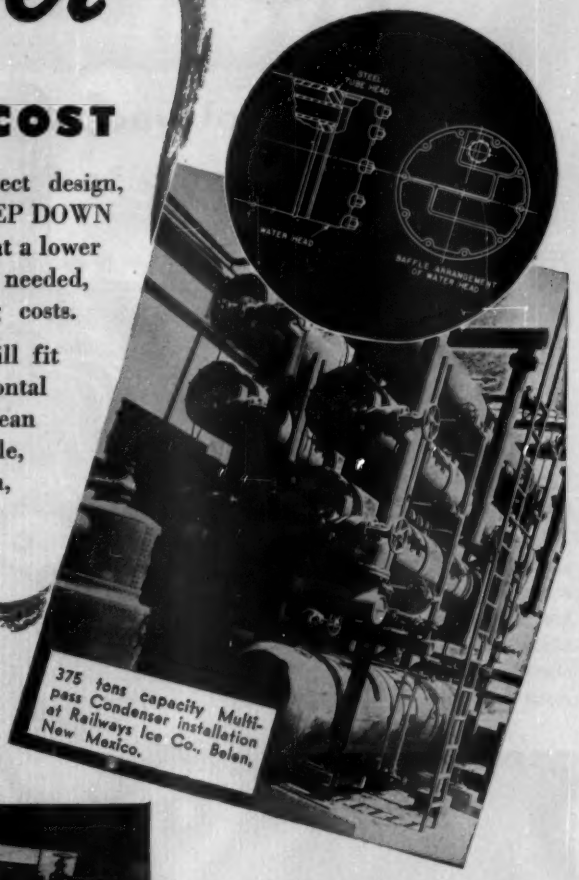
$ave Power and REFRIGERATION COST

Vogt Condensers, because of their correct design, STEP UP the rate of heat transfer and STEP DOWN head pressures. With the liquid delivered at a lower temperature, smaller compressor capacity is needed, saving in original as well as operating costs.

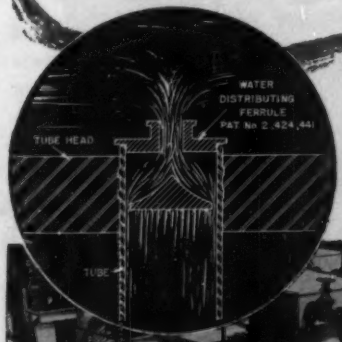
One of the two basic types illustrated will fit your operations exactly. Install Horizontal Multipass (closed type) for use with clean waters. Where the water is hard, forms scale, contains mud or promotes fungus growth, Vertical Single Pass (film type) which can be cleaned in operation, are recommended.

Horizontal Multipass Condensers
(Closed Type)

Water circulated in tubes traverses the length of the unit a number of times as determined by baffles in the heads.

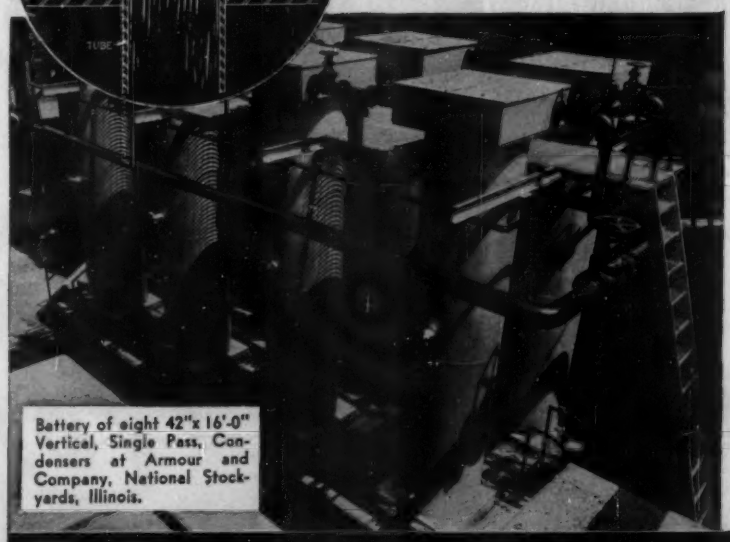


375 tons capacity Multipass Condenser installation at Railways Ice Co., Belen, New Mexico.



Vertical Single Pass Condensers
(Film Type)

Patented ferrules give equal distribution of water to and over the surfaces of all tubes in a unit.



Battery of eight 42"x 16'-0" Vertical, Single Pass, Condensers at Armour and Company, National Stockyards, Illinois.

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Vogt REFRIGERATION CONDENSERS

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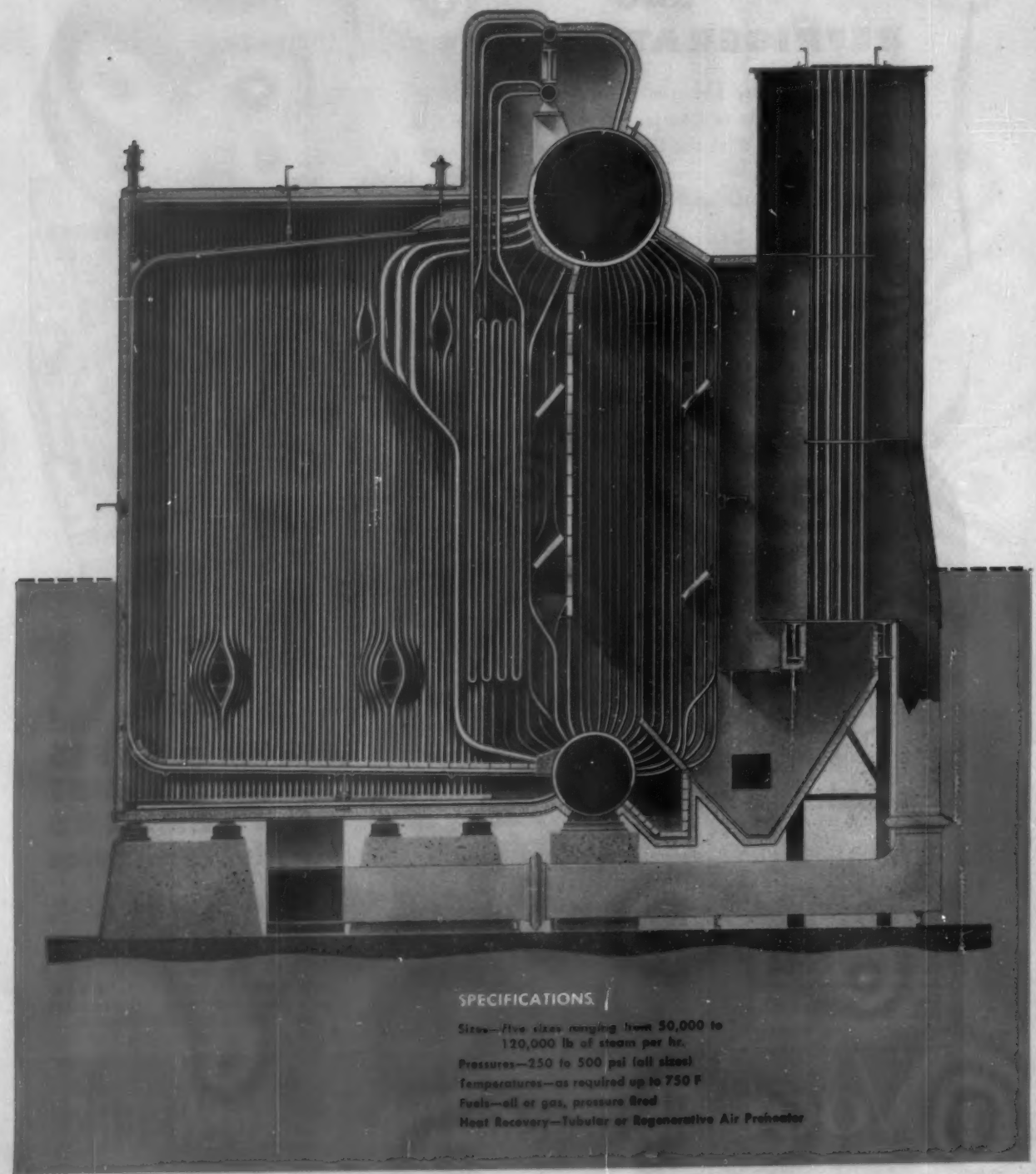
These performance-proved features



SPECIFICATIONS

Size—Five sizes ranging from 50,000 to 120,000 lb of steam per hr.
Pressures—250 to 500 psi (all sizes)
Temperatures—as required up to 750 F
Fuels—oil or gas, pressure fired
Heat Recovery—Tubular or Regenerative Air Preheater

make Combustion's NEW VU-55

today's outstanding boiler buy for capacities from 50,000 to 120,000 lb of steam per hour!

The VU-55—a development of Combustion's basic *V*ertical *U*nit design—offers features never before available in a boiler of its capacity range. If your steam needs call for a unit in the 50,000 to 120,000-lb class, you will find it worth while to consider the economic and operating advantages assured by these VU-55 features:

TANGENTIAL FIRING. More than 20 years of application experience have established the exceptional advantages of tangential firing, illustrated and briefly described below. About 90 percent of Combustion's large utility installations use this advanced method of firing.

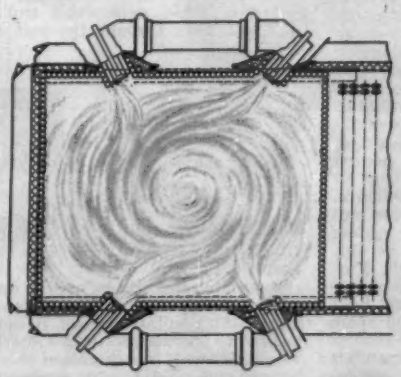
DOUBLE WALL, PRESSURIZED CASING. The latest development in casing construction for pressure firing of boilers in the size class of the VU-55, this casing, as illustrated and described below, is designed to assure life-time tightness with minimum heat loss. Pressure firing permits the elimination of an induced draft fan with its attendant operating and maintenance costs.

TANGENT FURNACE TUBES. The VU-55's furnace tube arrangement provides complete heat-absorbing, water-cooled protection on all furnace walls. Furnace maintenance is minimized, refractory expense is eliminated, heat absorption rates per sq ft are higher.

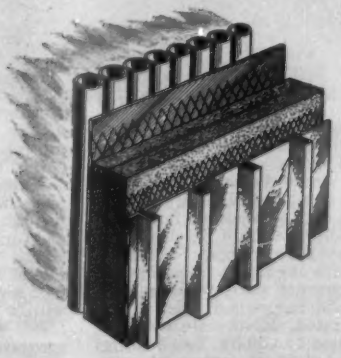
HIGH STEAM QUALITY. Equipped with a large (60-in.) steam drum, the VU-55 has generous water capacity and steam reservoir space. C-E drum internals assure high quality steam at all ratings.

STREAMLINED EXTERIOR. The over-all appearance of the VU-55 reflects the efforts of its designers to achieve a completely unobstructed casing, while retaining adequate access wherever required and every facility for convenient operation. There are no outside downcomer tubes, and ducts from air heater to burners are beneath the furnace floor.

Your request for further information on the VU-55 Boiler will receive prompt attention.



PLAN VIEW OF FURNACE showing arrangement of burners for tangential firing. Flame streams from the four burners impinge upon one another at high velocity, creating a turbulence unattainable by any other method of firing. The result is rapid and complete combustion. As the gases spiral upward, they sweep all furnace heating surfaces, assuring a high rate of heat absorption.



PERSPECTIVE OF FURNACE WALL. Construction consists of tangent tubes backed up successively by welded steel panels, 4 inches of high quality insulating material and an outer steel casing formed as shown to provide adequately for expansion and assure ample strength. Low heat loss and the tightness required for pressure firing are assured by this welded, double-wall construction.

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B-870

STEAM GENERATING UNITS; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; DOMESTIC WATER HEATERS; SOIL PIPE

For more data circle 531 on Post Card

EQUIPMENT NEWS

Described on these pages are new and improved products. Use Reader Service Cards on pages 117–118 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

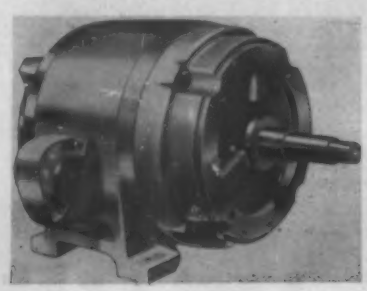
1—SCALE REMOVER offers greater safety, fast cleaning

Mogul Kwik-Kleen is announced for the rapid removal of scale from evaporative coolers and condensers, shell and tube condensers, hot water heating coils, heat exchangers, compressors, intercoolers, after-coolers, boilers and other equipment. It is claimed to offer increased safety to both personnel and equipment. It won't irritate hands or arms, says manufacturer, and hands can be held in the solution for 10 to 15 min with safety. Mogul Kwik-Kleen does not produce toxic fumes or burn holes in clothing or shoes, company adds, and it is not necessary to wear gloves, goggles or face masks when using it.

The product is packaged in moisture proof bags packed in drums. No weighing or measuring is required — just dissolve the granules in water and it's ready for use. Cost is reported comparable to that of other methods. The North American Mogul Products Co.

2—PUMP MOTOR is compact, close-coupled unit

This Uniclosed Close-Coupled Pump Motor, with a face type registered bracket and special shaft, is announced as offering more horsepower in less space. Built to rerated NEMA specifications, pump may be mounted flush with motor by bolting to face bracket. This method of coupling, company notes, insures accurate alignment of pump and motor. To prevent water from entering motor, a solid flange and brass slinger are incorporated. Motors are available in ratings from 1 to 30 hp. Ball bearings incorporate Lubriflush system of lubrication. U. S. Electrical Motors Inc.



3—BALL JOINTS, for piping; are lighter, stronger, cost less

Ball joints of new design in 8-, 10- and 12-in. sizes are offered in flanged end and welding end patterns in steel or Bar-Ductile metal. Flanged end joints are available with 150- or 300-lb flanges. Joints with welding ends are announced as suitable for 600 psi steam and operating temperatures to 1000 F. All of these joints are claimed lighter, stronger than company's previous design, and they sell for less. Both end patterns may be equipped with company's general purpose composition No. 11 gasket for gasoline, oil, water, non-corrosive chemicals and steam up to 300 lb. This gasket is suggested for tank settling or expansion movement; other gaskets are available for special services. Outstanding advantages announced for the joints are resistance to fire and 15-deg angular flexing. Barco Mfg. Co.

4—ELECTRIC CONTROL for tube expanding

This electric control for tube expanding is reported to assure the same expansion of each tube after metal-to-metal contact regardless of small variations in size of tube and tube sheets. Control is a torque-limiting device designed for use with any standard tapping motor. Its construction is sturdy and compact, company points out, and its operation is simple. It features a voltage balancer which eliminates need for a voltage regulator by automatically balancing out all outside voltage variables that effect calibration of control, such as variable line voltage, also losses due to worn brushes, different lengths of cord.

Once voltage is balanced and torque control set, no adjustment is needed during tube rolling operation except an occasional check on voltage balance. Any one of three standard tapping motors with built-in reversing gear system and quick-change chucks can be furnished with the electric control. Furnished with electric control are a ten-foot service cord, a remote signal light with a 25-ft extension cord, and spare fuses. When motor and electric control are purchased together, three expanders with spare rolls and mandrels are included. Lagonda Div., Elliott Co.

5—WATER CHILLERS for outdoor installation without enclosure

This company's CenTraVac line of centrifugal water chillers is announced as now available for outdoor installation without protective enclosures. All sizes from 50 to 800 tons refrigeration capacity can be obtained with this optional feature. Hermetic construction and automatic operation make the CenTraVacs well suited for outdoor use with only minor modifications, it is pointed out. Purge unit, control panel, conduit boxes and capacity control mechanism are weatherproofed and provided with electric heaters to prevent condensation; and the insulation is waterproofed. The Trane Co.

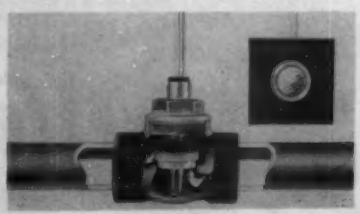
6—ELECTRONIC CONTROLLER designed for rack mounting

For mounting on a standard radio relay rack, this electronic process control unit is available with prefabricated cable for connection to other components in company's American-Microsen Electronic Process Control System. Rack mounting

simplifies mounting and affords accessibility of control adjustments, it is noted. Control units can be mounted one above the other to form a continuous panel surface with all control adjustments at the front for proportional, reset and rate actions. Controller racks can be placed within the panel cubicle, to the rear or sides of the panel enclosure, or anywhere in the instrument room. Since this control system has no mechanical connections between units, the components can be located where convenient. Industrial Controls Div., Manning, Maxwell & Moore, Inc.

7—FLOW INDICATOR is simple and compact instrument

For indicating flow (or lack of flow) of a liquid through a pipe line, the Model FI-200 is described as unusually compact and simple, dependable and easy to install. Flow through the unit actu-



ates a switch that can be used to operate a pilot light, horn or other warning signal. With suitable relays, it can also be used to operate preventive interlocks. The instrument is constructed of marine bronze and plastic, with duplex nylon jacketed lead wires. The switch unit, hermetically sealed in glass, is claimed corrosion resistant, and explosion-proof. The body of the flow indicator is a standard pipe fitting; standard pipe sizes from ¼ to 3 in. can be accommodated. Normally any flow over 1.5 gpm causes the indicator to function, but higher or lower points can be provided. Gems Co.

8—MULTIPLE RELAYS for outdoor switching

Series 100 and 200 Multiple Relays are designed for outdoor use as pilot wire control or for cascading street lighting

No time out for this CRANE valve in 40 years on main steam service

THE CASE HISTORY—Two Crane 250-pound iron body angle valves—6-inch (shown) and 5-inch size—scored this exceptional service record.

They were installed in 1915 on the main steam leads from boilers in the plant at Delavan, Wis., now occupied by The George W. Borg Corporation. In 40 years' uninterrupted service these Crane valves never failed to operate properly nor caused a shutdown. With but routine maintenance, they opened fully and were seated tight with ease under infrequent operation. Working pressure of boilers was originally 150 psi.—later reduced to 75 psi. This year, both valves were retired. The new replacements are Crane quality valves, of course.

Crane iron valves in particular need no introduction to thrifty buyers. In all grades, Crane iron castings generously exceed the requirements of equivalent A.S.T.M. specifications. Crane Ferrosteel, for instance, used in 250-pound valves is 35% stronger than ordinary cast iron.

In any pressure class, you'll find Crane quality outstanding. Choose from complete lines of gates, globes, angles and checks. Your Crane Representative can give valuable help in specifying and ordering.

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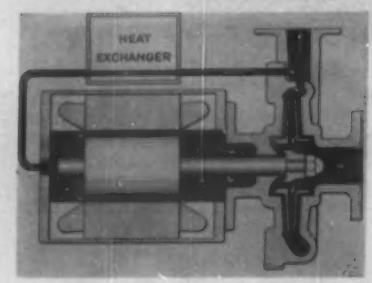
circuits, in low voltage installations. According to company, they incorporate a rugged, high quality, mercury plunger relay conservatively rated to switch 30 amp at 115 v a-c. Mercury-to-mercury contact and a stainless steel plunger which moves in an hermetically sealed tube is said to assure trouble-free operation and clean load current switching. Series 100 relay is housed in a standard weatherproof watt-hour meter case enclosure for safe and easy handling. All components are mounted on a bakelite sub-assembly chassis providing surge and lightning protection. Standard models are available with or without protective equipment. The low cost Series 200 is housed in a small weatherproof cast aluminum case. Both series are available with either normally open or closed relays. The Fisher-Pierce Co.

9—FUEL OIL ADDITIVE has gel breaking action

Desludgit, a heavy fuel oil additive, features unusual gel breaking detergent action, it is announced. Non-corrosive and non-explosive, the product has a flash point of 206 F. It is designed to break-up oil water gels, dissolve sludge, and emulsify water in the oil. The net result of using Desludgit, company points out, is that the fuel system remains clean from fuel tank to chimney, because all the oil is consumed at peak atomization efficiency. Company offers free demonstration kit for qualified power engineers, please state your company and job title when requesting this. Stewart-Hall Chemical Corp.

10—"CANNED MOTOR" PUMPS for high temperature use

Combining an integral heat exchanger with high temperature pump design, this newest of company's "canned motor" pumps is announced as ideal for Dowtherm, Arochlor, hot fats, hot oils and similar fluids. As with previous models, pumped fluid enters motor chamber of the combined motor pump. However, the "necked down" area between motor



and pump sections (see diagram) provides both a thermal barrier and a narrow restriction for passage of hot pumped fluid. A secondary impeller, on the rotor, circulates rotor chamber fluid through a water-cooled heat exchanger in the circulation line. Intermixing of hot fluid in pump changer and relatively cool fluid in rotor chamber is slight. Depending on cooling water temperature, these pumps handle fluids as hot as 1000 F, says manufacturer.

Offered as the Model CHS, available in 5- and 7½-hp sizes, and Model CFT in ¾ and 1½ hp, these pumps develop maximum head of 195 ft. Maximum capacity is 250 gpm. Chempump Corp.

11—GATE VALVE permits quick, easy replacement of seat rings

With this renewable seat ring gate valve, you can replace seats in 7 to 10 min, under all conditions, says manufacturer — and with the valve body still installed in the line. All you need is a screwdriver. As shown in the photographs above, you disassemble the bonnet, then unscrew and lift out the seat rings from the body with your fingers. The new rings slip into place and are secured again with set screws.

The noteworthy construction feature of this valve, as explained by company, is that the angle of the pointed end of the retaining screw is complementary to the angle of the seat ring. The resultant line of contact holds the seat rings securely and rigidly in place, it is stated, and without excessive pressure being put on the screws, which are silicon bronze and won't gall or freeze. Supplied with rising stem, in six sizes from ¼ to 2 in., this valve is designed for severe service conditions on 200 lb steam, 400 lb water, oil or gas lines requiring full flow, frequent use. The Fairbanks Co.

12—SOUND DETECTOR finds defects in machinery

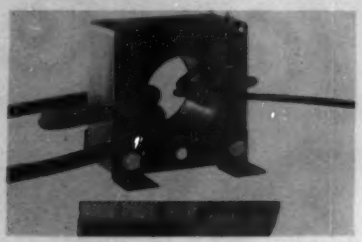
An improved listening device, the Engineer's Sound Detector, is claimed to enable detection of the smallest internal defects in moving machinery without taking the equipment out of service. It amplifies normally inaudible defect-caused noises, says company, and lets you locate broken, loose, worn or bent parts in reciprocating engines, motors, gear boxes, compressors, pumps. It is also reported useful in determining efficiency of steam traps and locating leaks in underground piping.

Resembling a doctor's stethoscope the Engineer's Sound Detector utilizes dual detectors to transmit sounds to one or both ears as desired. Each detector contains both a pick-up diaphragm and an amplifying diaphragm to provide maximum sound vibrations. The twin detector feature makes possible listening to two different points at a time. A pair of extension rods are furnished with the device for reaching into remote places, and an interchangeable bell stethoscope is also supplied for detecting pressure or vacuum leaks around head gaskets, manifold, etc. The standard model detector sells for around $15.00 — a de luxe model for around $20.00. Burke & Co.

13—BREATHERS, DRAINS for humid hazardous areas

This stainless steel universal breather and drain, the Type EDC, allows passage of up to four times more volume of air than many types, according to manufacturer. The new devices are intended for use on explosion-proof combination starters and circuit breakers, as shown, and other equipment housings in Class I, Groups C and D hazardous locations.

The breathers and drains have two functions: to drain off accumulated water, resulting from condensation, in the base of the explosion-proof housing; and to ventilate the housing by allowing constant recirculation of air, thus minimizing condensation. Larger air passages serve to prevent clogging due to dust and small dirt particles, it is noted. The units can be installed in explosion-proof housings by screwing them into hubs or holes tapped for conduit having five or more threads. This connection assures safety, company says, since at least five threads on the breathers and drains will be engaged. Crouse-Hinds Co.



14—CURRENT TRANSFORMER for panel, switchboard uses

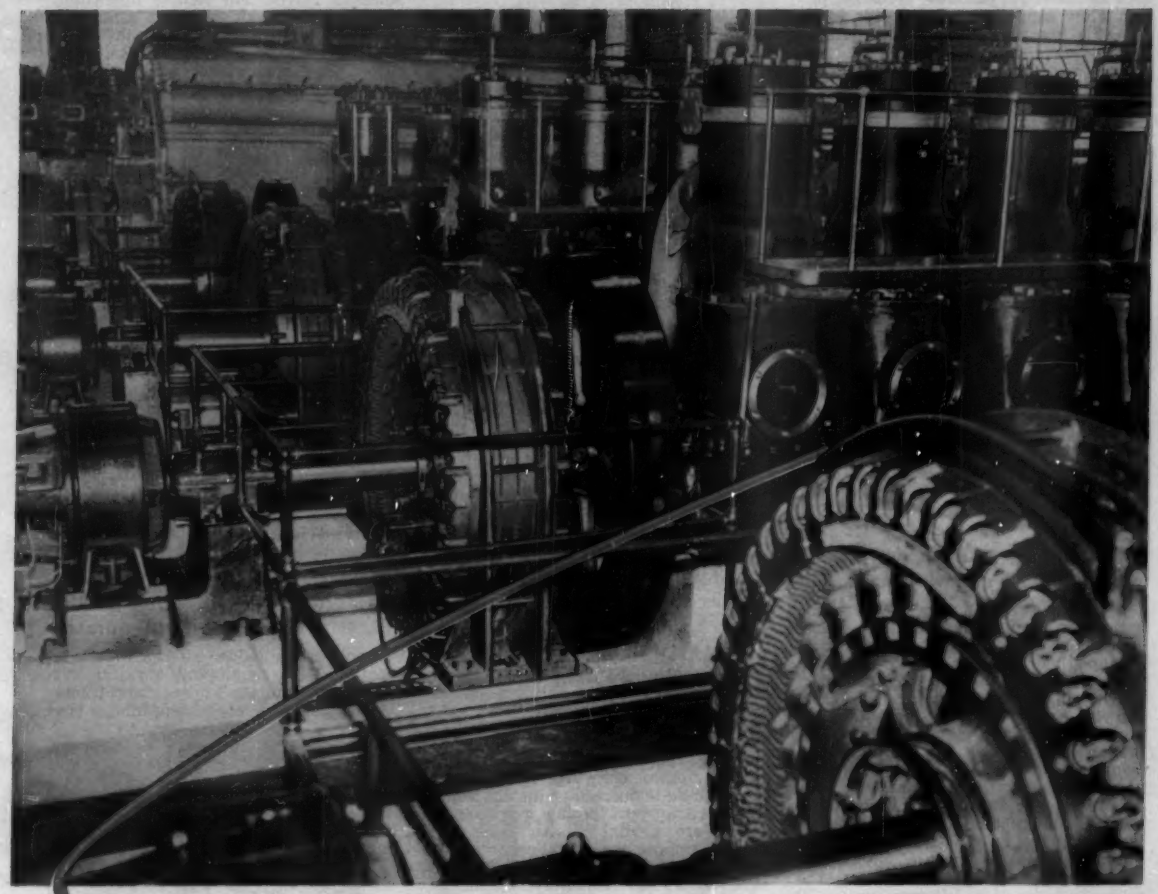
Type JCH-O 600-v Current Transformer is suitable for operating ammeters and wattmeters, it is announced, in applications where revenue-metering accuracy is not required. It is described as compact, with flexible mounting arrangements, and constructed of molded butyl, which serves as insulation support and casing. Suitable for operation with a bare primary conductor on circuits to its rated voltage, it may be applied to higher-voltage circuits when used with an insulated primary conductor. Rated for 50–60 cycle service, transformer provides 7 standard primary current ratings from 100:5 to 800:5 amp inclusive. It is designed for continuous operation at 100 per cent of rated current in 55 C ambient temperature without exceeding the allowable 30 C rise. General Electric Co.

15—SOLENOID VALVE shuts off fuel oil on engines

Bulletin X-8015 Asco Solenoid Valve is designed to shut off fuel oil on gasoline or diesel engines in case of low oil pressure, high engine temperature, overspeed, low voltage, or other abnormal conditions where it is necessary to protect engine from damage. To operate, valve is opened manually and under normal conditions will remain open. This permits fuel to go to engine allowing it to be started in usual manner. In the event of any abnormal condition, valve is energized by respective control device closing valve and shutting off fuel supply to engine, thus preventing serious damage. Valve remains closed until manually re-opened.

It can also be used for stopping engine with a remotely located push button. The valve is supplied with a heavy brass

Resists Wear!



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GASCON OILS

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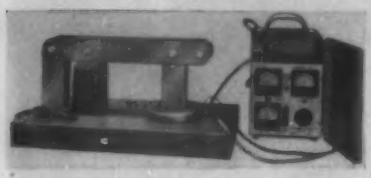
body and soft composition disc for tight shut-off. Solenoids are available with coils for any voltage. Valve can be mounted in any position, is designed to withstand engine vibration, and is designed for handling all types of fuel such as diesel oil, gasoline, kerosene, jet fuel. Flow capacity of ¼ in. pipe is 25 gph at a low pressure drop. Automatic Switch Co.

16—TESTER for field, armature and transformer coils, solenoids

This instrument is designed to detect shorts on one or more turns, detect opens, and show number of turns in a



coil from 10 to over 3000. Minimum coil opening is 2⅝ by 3 in. or 3⅞ in. diam. Maximum coil height is 6 in. The tester operates on 115 v 60 cycle a-c current. Transformer base is 12 by 24 in. The Martindale Electric Co.

17—PORTABLE PUMP, with vacuum switch, drains flooded spots

Designed to combat flooded floors, standing water on flat roofs and for other emergency use, this portable pump is equipped with a vacuum switch to permit untended operation. The pump weighs only 26 lb complete with motor, carrying handle and vacuum switch, but it has a capacity up to 5 gpm with pressures up to 30 lb. It can be moved from one spot to the other in the plant, whenever fast water transfer is required. The vacuum switch acts to guard against burned out impellers by stopping the pump's motor automatically when the liquid supply runs dry.

Handling clean or dirty water, the pump is designed to lift water up to 10 ft unprimed or 22 ft primed and has outside threaded ports for standard female garden hose couplings. The pump's hollow shaft slips directly on the motor shaft. The motor is a ¼ hp, 110 v, heavy duty capacitor type with manual reset overload protector and 5-ft cord. Hypro Engineering, Inc.

18—ALUMINUM PAINT produced in blue, green and gold

Using aluminum pigment supplied by Aluminum Co. of America and a special additive, this paint manufacturer has developed colored aluminum paint. Recent inspections of the Southern California Edison plant for which the paints were developed are reported to show that neither rain nor sun has noticeably affected the 2-year-old surface. The paint film — overlapping layers of metal flakes, five to 10 layers thick, cemented together by a watertight vehicle — is also said to have offered impregnable resistance to plant fumes and moisture. Experience on this installation also showed that a single coat covers and hides even a colored surface, says company. Although the colored aluminum paints were sprayed on in this installation, they can be brushed on when a suitable solvent is used as a thinner. A full range of colors in the aluminum-pigmented paint is under development, says manufacturer. Blue, green and gold are now being produced. Gilmore & Nolan, Inc.

19—EXHAUST FAN is heavy duty, propeller type unit

Designed specifically for industrial installations is the Model K Ventura Fan, available with two-speed or constant-speed direct drive totally enclosed motors. A large range of sizes cover capacities from 587 to 12,800 cfm. The heavy duty propeller type fan will operate against static pressures up to ½ in., it is noted, and its streamlined inlet permits a free flow of air with minimum resistance in exhausting smoke, and fumes. American Blower Corp.

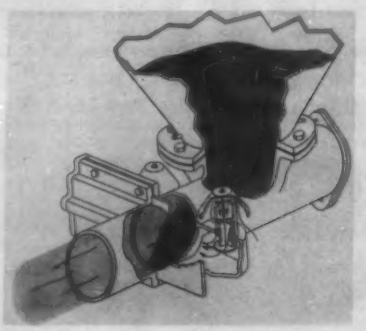
20—TORQUE REDUCER for the large size valves

Recently introduced is a planetary gear torque reducer which permits one-man operation of this manufacturer's 10-, 12-, and 14-in. Saunders Patent Diaphragm Valve. The torque reducer provides a 5 to 1 mechanical advantage and is available on either handwheel or chain-operated valves. It may be had on new valves, or applied to those already in service. The gear assembly is mounted at the top of the bonnet and increases the overall height of the valve by only 7½ in. Hills McCanna Co.

21—MATERIAL HANDLING VALVES for boiler fly ash, other dusts

For pneumatic transport of fine solid materials, Type C Valves are said to offer advantages of self-feeding, non-plugging operation with positive shut-off, maximum carrying capacity and ease of maintenance. For installation in vacuum transport piping systems, the valves are available with either air-electric, remote or manual controls. The self-feeding feature eliminates plugging, says manufacturer. Atmospheric air, admitted into vacuum system through inlet ports, continuously picks up and sweeps material through the valve and into the transport piping at rates automatically matched to the increases and decreases of the load in the system. It is noted that because the rate of feeding is continuous and commensurate with the airflow, there is never any sudden application of full vacuum to plug the system.

The valves have sliding shut-off gates for protection against leakage. Also, they are claimed to permit maximum utilization of the carrying capacity of the piping system because high material concentrations permit use of smaller diameter transport piping. For air-electric operation, valves are equipped with air cylinders controlled by three-way solenoid valves. For remote operation, the valves have air cylinders controlled by three-way valves mounted on a central control panel. For manual operation, they have either push-pull rods (where valves are hand high) or with chain wheels and hand chain (where overhead). The Allen-Sherman Hoff Co.



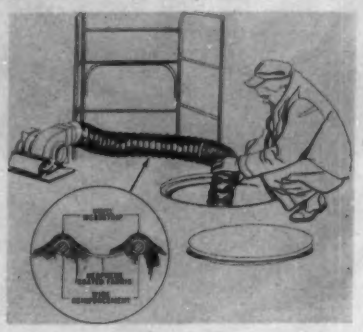
22—MOTOR, for tube cleaners, is water driven unit

This ball-bearing water-driven motor is suggested for plants where air and steam are not available for operating tube cleaning equipment. In certain industries, the water-driven motor will be more practical to use, company points out, as it is a cleaner operation than using air or steam. The motor is designed for use with either high or low pressure. Manufacturer says it will operate on far less pressure than previous models, and is 75 per cent more powerful.

In design this motor and its cleaning or expansion head are shorter than other types, making it adapted for work in curved as well as straight tubes. It can be used in tubes of 1¼ to 4 in. ID. It is priced lower than steam- and air-driven models. The Airetool Mfg. Co.

23—LIGHTWEIGHT HOSE available with vinyl wearstrip

To protect and reduce exterior wear from contact with rough and abrasive surfaces, this company's hoses and retractable ducts made of coated fabrics and



spiral wire reinforcement are now available with an added vinyl wearstrip. This wearstrip is bonded over spiral wire reinforcement, and where hose is most exposed to abrasion and damage. In many spot air conditioning, ventilating, dust collection, fume control and materials handling uses, where lightweight flexible hoses are frequently dragged over rough surfaces, company points out, this wear resistant feature affords a longer service life. The Flexaust Co.

24—CONTROL PILOT regulates pressure and temperature

Standard Type 51 pilot is said to provide extremely accurate and dependable control of pressure and temperature. The pilot is applicable for pressure ranges from 0–15 to 0–10,000 psi, and 0–30 in. H_2O and 0–30 in. Hg vacuum. Pressure-

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BIDDLE *Instrument News*

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SAVES TIME in Electric Motor Hook-Ups

This tester eliminates the need for temporary connections which can be time consuming, costly, and quite hazardous, particularly where many large high-voltage motors are involved. With this instrument you can very easily determine direction of rotation for any size 1, 2 or 3-phase motor, and make your first connections *permanent* ones with safe assurance they are correct. You can use it also to test circuits, check phase sequence and identify windings of multi-speed or multi-voltage motors.

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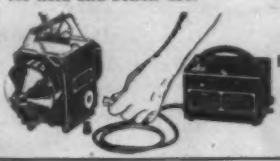

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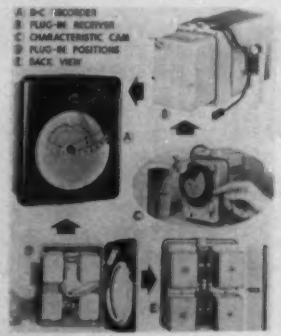
sensing elements are available in phosphor bronze, beryllium copper or stainless steel. Temperature ranges from −40 F to 1000 F, with mercury-actuated armored capillary temperature-sensing element available with plain bulb, union connection or union connection with separable socket. Other features are incorporation of process pressure or temperature gage in pilot; calibrated set point adjustment; unit construction; feedback proportional control, with 1 to 100 per cent proportional band and differential gap; availability with proportional, plus automatic reset action; all-metal, frictionless power relay incorporating jewel nozzle feed orifice with pushbutton cleaner. Pilot can be ordered separately or on control valve. A. W. Cash Co.

25—RECEIVER-RECORDER for d-c pickups, telemetering systems

The recorder of this electronic instrument may house as many as four plug-in, d-c receivers, or may incorporate two receivers and two pneumatic controllers. Non-linearity, inherent in many pickups, is extracted by a characteristic cam



in the receiver, it is noted. Thus, it is declared possible to combine four records from d-c pickups, a-c pickups, or pneumatic transmitters on the same uniformly-graduated, circular chart. As pointed out by manufacturer, this feature makes individual recorders and special charts unnecessary, it conserves panel space, provides equal reading accuracy at any point on the chart.

The d-c receiver operates on the potentiometric null-balance principle, using an electronic voltage reference in place of usual standard cell and battery. Frequent periodic interruption of measurements or control for standardizing purposes is eliminated, it is stated. The receiver is a single, protected package, with unitized, interchangeable component sections. Full data on this receiver-recorder is given in Product Specification E12-4. Bailey Meter Co.

26—DUST COLLECTOR has greater storage capacity

The Model 30NW50 Dustkop Dust Collector is announced for use where greater dust storage capacity is necessary. It has an air handling capacity of 3600 cfm, with a static pressure of 6 in. of water, and is claimed capable of collecting dust from practically any dust creating machine or operation, especially where the dust volume runs to rather high bulk. Collector eliminates emptying of a regular dust bin by shovel, with the addition

SURGEABILITY...

THE LATEST WORD IN WATER TREATMENT

Surgeability is defined as stability of performance under rapidly changing and unpredictable conditions including flow. This characteristic is vitally important in clarification and cold process softening installations. Surgeability is designed and built into the Graver Reactivator®.

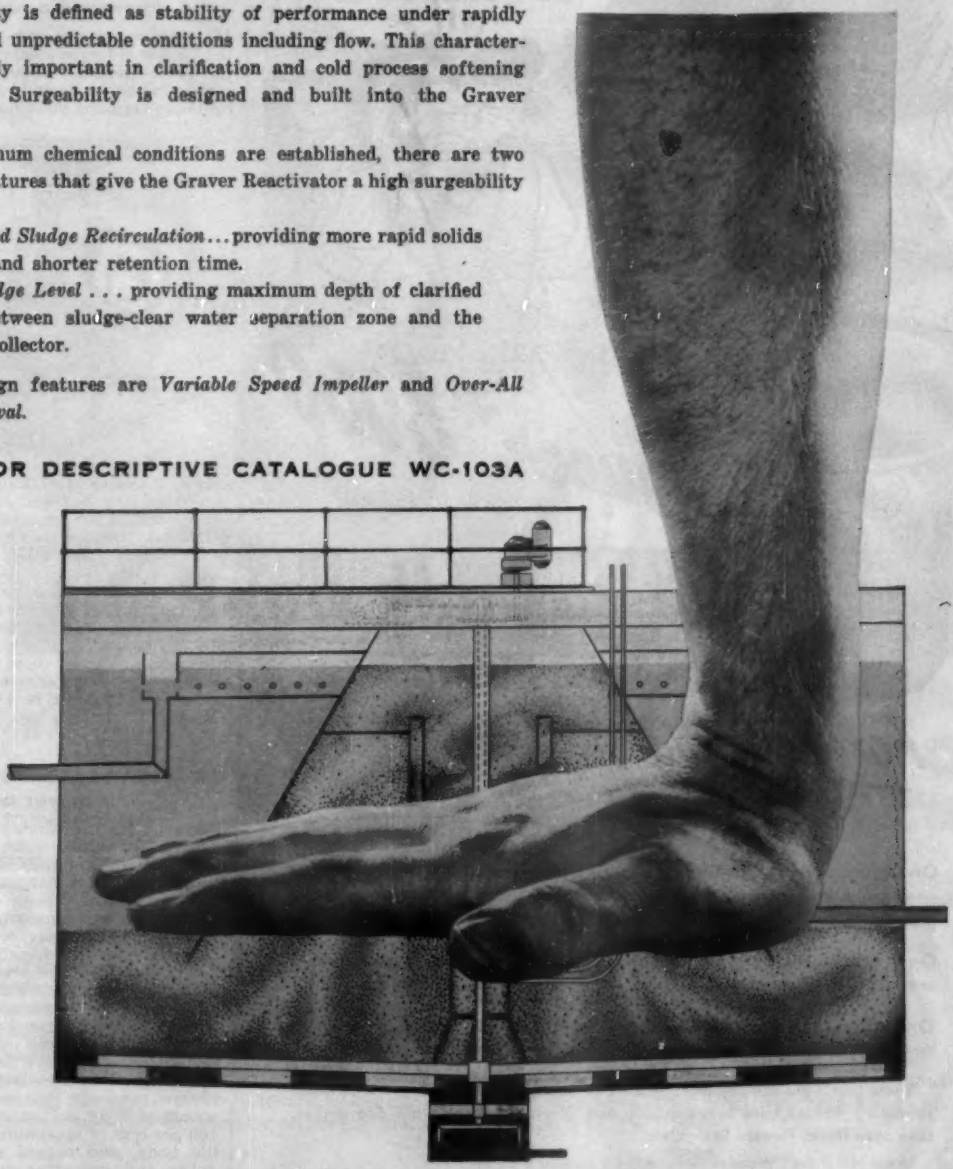
Once optimum chemical conditions are established, there are two important features that give the Graver Reactivator a high surgeability factor:

Controlled Sludge Recirculation... providing more rapid solids contact and shorter retention time.

Low Sludge Level . . . providing maximum depth of clarified water between sludge-clear water separation zone and the effluent collector.

Other design features are *Variable Speed Impeller* and *Over-All Sludge Removal.*

WRITE FOR DESCRIPTIVE CATALOGUE WC-103A



Department NK

GRAVER

GRAVER WATER CONDITIONING CO.

A Division of Graver Tank & Mfg. Co., Inc.

216 West 14th Street, New York 11, N. Y.

For more data circle 536 on Post Card

REFRACTORY CEMENT

- BONDS STRONGER
- LASTS LONGER

For Example-

On Induced Draft Fan Casings—Where previously repairs required heavy, abrasion-resistant steel plates, now a coating of Super #3000 provides safe protection for many months against the scouring action of fly ash.

On Inside Duct Lining—A ¾" thick layer of Super #3000 over the insulation provides long-life refractory lining that withstands erosion of hot abrasive gases.

On Boiler Tubes—By painting the tubes in the passes of the boiler with a thin mix of Super #3000, considerable protection is provided against erosion.

There are a great many more reports of Super #3000 success—where other refractory mortars have failed quickly and utterly—in boiler walls and arches, coke oven floors, furnace linings, etc.

Users call it the "Wonder Cement." Try it—you'll agree.

REFRACTORY & INSULATION CORP.

REFRACTORY BONDING AND CASTABLE CEMENTS
INSULATING BLOCK, BLANKETS AND CEMENTS

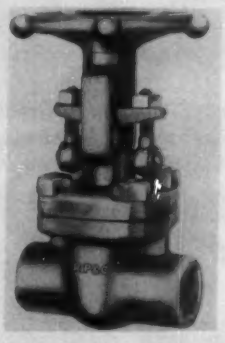
130 WALL STREET • NEW YORK 5, N. Y.

For more data circle 537 on Post Card

of two rubber caster, roller dust cans that are connected to the collector by an all metal diversion Y. It is available as a recirculating air unit, or with attachments for outside exhaust where state codes, or the nature of the type of dust prohibits recirculation of the air within the plant. Clamp-on lids and Y connection are self-suspending for roller can removal and dumping. Aget Mfg. Co.

27—STEEL GATE VALVES offer improved design features

Major improvements announced for company's line of forged steel gate valves for the petro-chemical, power, and process piping industries include stainless steel eyebolts, stainless steel nuts, a sturdier



gland, stainless steel follower, a redesigned stuffing box and smoother operating stem. The combination of a 500 BHN heat treated stainless steel wedge with stainless seat rings, hard chrome plated, is designed to resist seizing and galling, as well as abrasive wear. Stuffing box consists of molded asbestos, wire reinforced and mica lubricated — reducing the possibility of pitting of stainless steel stem. Valves come in sizes from ¼ to 2 in., with either screwed or welded ends. R-P & C Valve Div., American Chain & Cable Co., Inc.

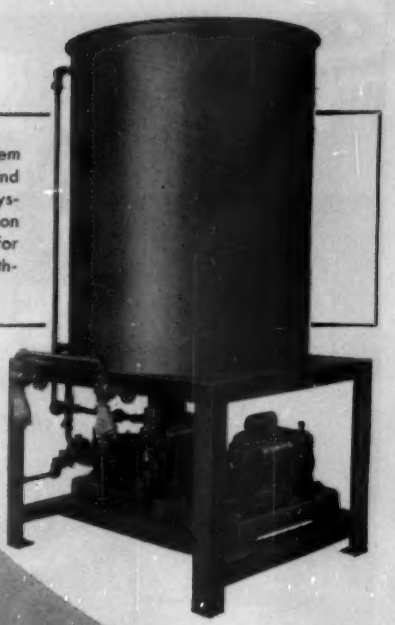
28—FLOW-RATE CONTROLLER is power actuated unit

Designed for the effective operation of systems in water, waste or industrial plants, the Model RCB-T Controller comprises venturi metering and pressure recovery sections, a power-actuated valve mechanism, and a pneumatic, hydraulic or electric positioning control unit. Its cast iron body, for working pressures to 125 psi, has pressure-averaging annulus at inlet and closed annular chamber with multiple vents at throat. The venturi throat section is bronze lined, and the unit comes equipped with a rubber-seated butterfly valve for tight closure.

Among advantages cited for this rate-of-flow controller are control accuracy within ± 3 per cent ranging from 25 to 100 per cent of maximum capacity, long life body, and rugged construction of valve and operating parts. Builders-Providence, Inc.

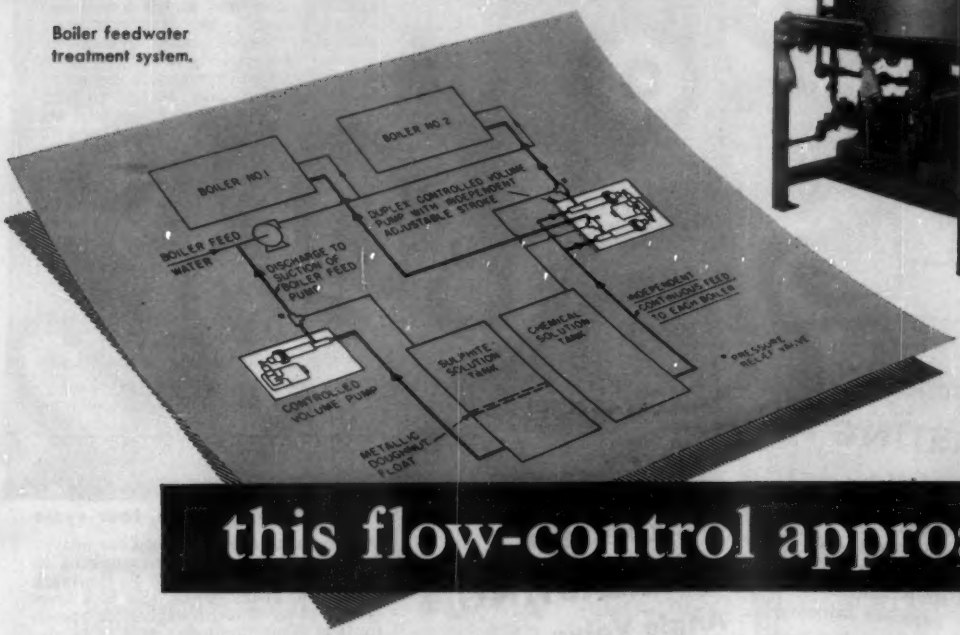
29—PACKAGED GENERATORS are electrically operated

Speedylectrics are self-contained units operating on the electrode principle of generating steam electrically and are announced as UL listed in sizes from



Typical Milton Roy packaged system —comprising a chemical tank and two Controlled Volume Pumps. Systems supplied with chemical solution tanks up to 500 gal. capacity . . . for any boiler pressure . . . with or without automatic control.

Boiler feedwater treatment system.


BOILER NO. 1
BOILER NO. 2
DUPLEX CONTROLLED VOLUME PUMP WITH INDEPENDENT ADJUSTABLE STROKE
BOILER FEED WATER
DISCHARGE TO SUCTION OF BOILER FEED PUMP
CONTROLLED VOLUME PUMP
SULPHITE SOLUTION TANK
CHEMICAL SOLUTION TANK
METALLIC DOUGHNUT FLOAT

this flow-control approach

cuts cost of boiler water treatment . . . boosts boiler and turbine life

REDUCED chemical costs, increased boiler and turbine life . . . result when treating chemicals are *accurately* metered in boiler water treating systems.

This simple packaged system, for example, provides an economical solution to the continuous treatment of boiler feed water. A simplex Controlled Volume Pump injects sodium sulfite directly into the reservoir of the deaerating heater, thereby removing residual oxygen and preventing pitting of economizers and boiler feed pumps. A duplex Controlled Volume Pump meters phosphate directly to the boiler drum of each of two boilers, thereby removing dissolved minerals and preventing scale formation in boiler tubes.

Milton Roy engineers and fabricates complete packaged systems for the treatment of boiler feedwater, with all necessary piping, valves, and liquid level gauge. Agitators, dissolving baskets, instrumentation, and alarms can also be furnished, as desired.

How can we serve you?

Write for technical information. Or, send your problem to Milton Roy Company, *Manufacturing Engineers*, 1300 East Mermaid Lane, Philadelphia 18, Pa.

Engineering representatives in the United States, Canada, Mexico, Europe, Asia, South America, and Africa.

milton Roy
CONTROLLED VOLUME PUMPS

For more data circle 538 on Post Card

DOUBLE BOILER BLOW-OFF SAFETY

1

Quick-Operating
EVERLASTING
Straight-Through Valve

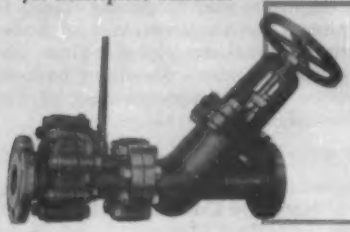
The standard Everlasting design which opens with a quarter-turn of the lever and closes with a drop-tight seal that actually improves with use.

2

Shock-Resisting
EVERLASTING
Angle Valve

Specially designed and stoutly constructed to withstand severe service and the shocks and abrasion of blow-down solids.

Conform with ASME codes. Available in a range of sizes for pressures up to 600 psig. *Write for descriptive bulletin.*



EVERLASTING DUPLEX UNITS

also available with Y Valves and in any combination of Quick-Operating, Angle and Y Valves.

For "everlasting" service, use

EVERLASTING Valves

EVERLASTING VALVE CO.
47 FISK STREET, JERSEY CITY 5, N. J.

EV 200

For more data circle 539 On Post Card

1½ to 15 Bhp. They are suggested for use where precise control of high pressure steam temperature is desired: in places where fuel-fired boilers create an explosion, fire or fume hazard; or as supplementary steam sources for areas remotely located from central boilers.

In these generators, three electrodes are suspended in a generating chamber within the pressure tank. When electric current is turned on, heat is generated by the resistance of the water to passage of current between the solid metal electrodes. The water itself acts as the resistance element, says company; and no low water damage is possible because, as the water level in the generating chamber drops the electrodes are progressively uncovered and less and less current passes — this automatically slows the rate of steam generation. Economy of electricity is claimed to be effected by this compensating action.

Speedyelectrics may be operated on 220, 440, or 550v power supply and are reported to offer special advantages to plants having 440 or 550v power. For these voltages, Speedylectrics require only ⅓ to ½ the floor space occupied by fuel-fired boilers of equal capacity, says manufacturer, Pantex Mfg. Corp.

Reader Service Cards on pages 117–118 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

30—MEDIUM SPEED ENGINE is 400 to 1400 hp, four-cycle

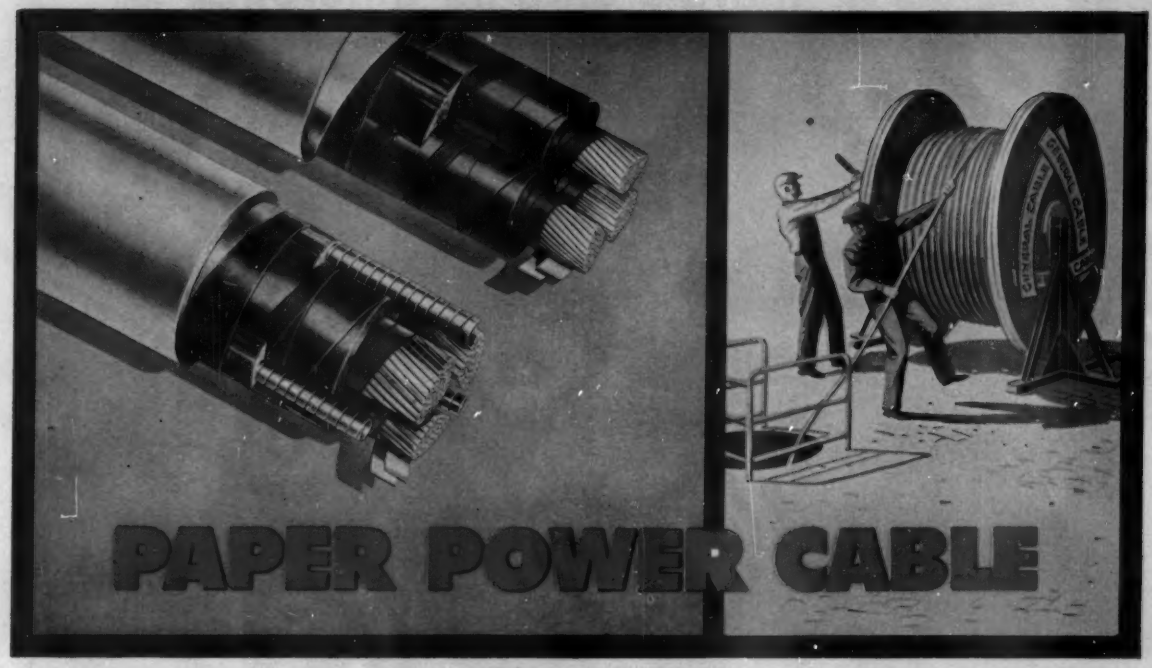
Developed to meet the need for heavy-duty continuous service engines in smaller sizes is the new W-9. Having a 9-in. bore, 11-in. stroke, this is a four-cycle 400 to 1400 hp engine for speeds to 1000 rpm. Company says it is designed throughout for turbocharging and capable of outputs in excess of 1400 hp at 1000 rpm, and of continuous operation at more than 200 psi bmep. For operating efficiency and economy, the W-9 can use the lowest cost fuels available, it is noted . . . residual, crude and distillate oils, natural gas, sewage gas, manufactured gas or propane.

Low fuel consumption and high power output of this engine are attributed to the "jet swirl" feature incorporated. Cast iron cylinder heads carry two inlet and two exhaust valves, equipped with hydraulic valve lifters which maintain constant clearance and reduce mechanical noise. The intake manifold at the top of the engine discharges air into a passage cast into the head which directs it into the cylinder in a direction almost parallel with inlet valve stems. Intake passages are designed to impart a turbulent swirling motion to the air as it enters the cylinder to assure rapid mixing of air and fuel. When the engine is equipped for dual-fuel operation, the gas admission valve is installed in the air inlet passage and operated by the air inlet valve rocker arm. By this arrangement, gas and air are mixed before entering the combustion space. Thus, it is explained, the gas valve can be kept open longer allowing use of fuel gases at lower pressures. Worthington Corp.

more Equipment News page 128

GENERAL CABLE

THE GREATEST NAME IN ELECTRICAL WIRE AND CABLE



Pioneers in the development of Paper Power Cables, General Cable Engineering leadership and manufacturing skill is combined to provide a *uniformly high quality product.* Conductors are made to finest possible tolerances, insulations are thoroughly tested and inspected before and after assembly — in fact, *every* step of manufacture is under the most rigid quality control.

The biggest producer, General Cable also makes the widest range of types. For example: solid, low pressure gas-filled, low pressure oil-filled, high pressure oil-filled (pipe type), high pressure gas-filled (pipe-type), and high pressure oil or gas-filled (self-contained).

Available in widest range of conductors: Compack Round, Concentric, Compack Sector, Annular Concentric, Compack Segmental, Hollow Core.

Made in largest variety of finishes: Jute, Duck Tape, Reinforced Neoprene, Synthetic Plastics, Flat Steel Tape or Steel Wire Armor.

The forementioned represent but a few of the wide range of types manufactured by General Cable... plus other types made to customer specifications.

Next time you're talking Paper Power Cable ... or any type of electrical wire and cable, call in your friendly General Cable Representative... there's one near you.

GENERAL CABLE
CORPORATION

BARE, WEATHERPROOF, INSULATED WIRES and CABLES FOR EVERY ELECTRICAL PURPOSE

GENERAL CABLE CORPORATION
Executive Offices: 420 Lexington Ave., New York 17, N. Y.

SALES OFFICES: Atlanta • Baltimore • Boston • Buffalo Chicago • Cincinnati • Cleveland • Dallas • Dayton • Denver Detroit • Erie (Pa.) • Greensboro (N. C.) • Houston Indianapolis • Kansas City • Lincoln (Neb.) • Los Angeles Memphis • Milwaukee • Minneapolis • New Haven • New Orleans • Newark (N. J.) • New York • Philadelphia Pittsburgh • Portland (Ore.) • Richmond (Va.) • Rochester (N. Y.) • Rome (N. Y.) • St. Louis • San Francisco Seattle • Springfield (Ill.) • Syracuse • Tampa • Tulsa Washington (D. C.)

For more data circle 540 on Post Card

Evenly matched or not...

there's enough difference to make all the difference

Before the bout, two fighters may look equally good to the fans. After a round or two, the differences begin to show up.

It's the same with heat exchanger tubes. They all start out looking pretty much alike, but under the test of day-in, day-out operation, Scovill Phosphorized Admiralty Heat Exchanger Tubes have consistently shown superior performance.

Hot-extrusion from Scovill Continuous-Cast billets means uniformity in the metal, uniformity of chemical composition and grain structure, uniformly high phosphorus content. It means sounder metal—smooth, dense, free from pits or porosity. These—plus Scovill's unrivaled Technical Application Services—are, indeed, differences that make *all* the difference in economical, uninterrupted service under tough operating conditions. Let us tell you more about them.

Scovill Manufacturing Company, Mill Products Division, 99 Mill Street, Waterbury 20, Connecticut. Phone PLaza 4-1171.

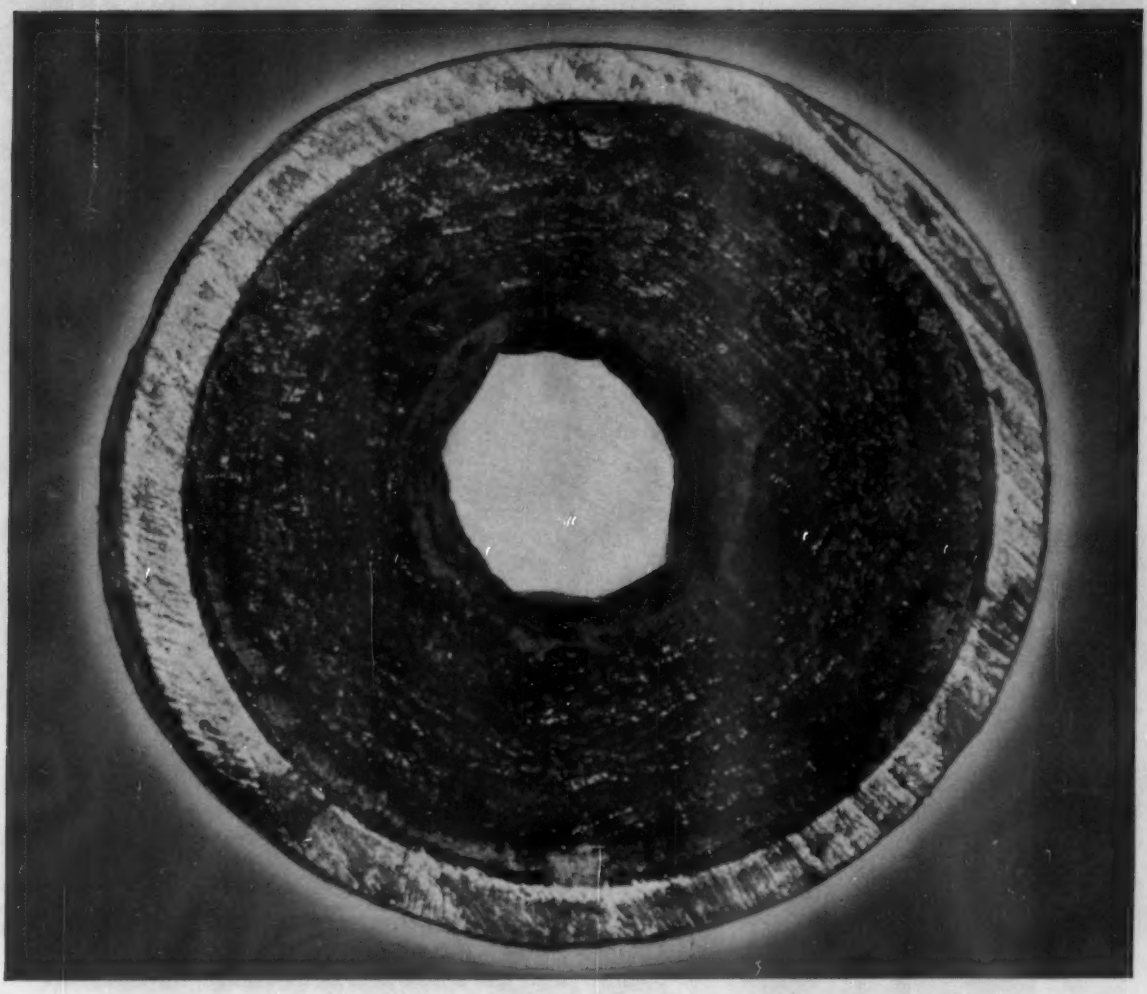
SCOVILL

HEAT EXCHANGER TUBE

Phosphorized Admiralty • Admiralty • Arsenical Admiralty • Muntz Metal • Naval Brass • Red Brass, 85% • Deoxidized Copper
Arsenical Copper • Copper Nickel, 10% & 20% • Cupro Nickel, 30% • Aluminum Brass • Aluminum Bronze, 5% • Duplex Tube

88CS8

For more data circle 541 on Post Card



END OF THE LINE

SCALE—layer upon layer of it—has reduced the inside diameter of this pipe to practically nothing. It's a common occurrence in some power plants, and the results are costly. The line must be taken out of service. That means production loss and expensive maintenance or replacement.

Scale, sludge, carry-over, and return-line corrosion are but a few of the problems that must be overcome to assure efficiency in boiler plant operation. In Dearborn's complete line of water conditioning products, there is the correct treatment to eliminate every water trouble—the properly balanced treatment to reduce unnecessary maintenance, avoid shutdowns, and protect valuable equipment.

Since 1887, Dearborn products have provided trouble-free water to users of steam in all types of industry. That's why, today, power engineers in leading industrial plants throughout the nation look to Dearborn for consultation and assistance in solving their water treating problems.

MAIL THE COUPON

Dearborn Chemical Company, Dept. PG
Merchandise Mart Plaza, Chicago 54, Ill.
Please send me complete information on Dearborn Water Conditioning.

Name.....*Title*.....

Company.....

Address.....

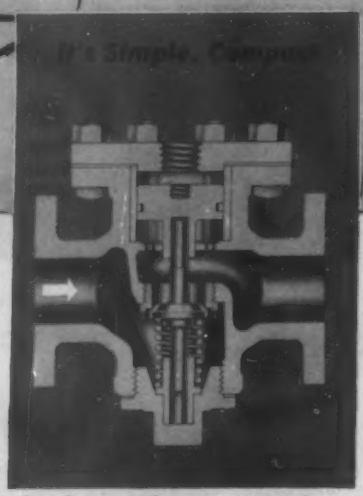
City.....*Zone*....*State*.....

Dearborn®

...a leader in water conditioning and corrosion control

For more data circle 542 on Post Card

This operating valve is *always* within *reach*



Simplicity and compactness keep cost *down*, reliability *up* in this Leslie Class LP operating valve.

Make a demand — the valve obeys. It's like having a third hand and a long arm as the control for this shut-off valve is *always* within *reach*.

You can get Leslie shut-off valves equipped with an electric solenoid valve (Class LG) or you can operate them remotely with an air or hydraulic relay valve. Valve opens and closes on demand of a manual or automatic signalling device (pressure switch, thermostat, etc.)

Designed for off-on service, there are units with body ratings to 1,000 psi and temperatures to 750°F. The valves give fast, tight shutoff of steam, air and non-corrosive fluids.

Ask your Leslie engineer to help you select the operating valve that's engineered to meet your service requirements. You'll find him listed under "Valves" or "Regulators" in your classified telephone directory.

Bulletin 5309 describes operating valves.
Send for it today.

TRADE LESLIE MARK

REGULATORS AND CONTROLLERS

LESLIE CO., 301 GRANT AVENUE, LYNDHURST, NEW JERSEY

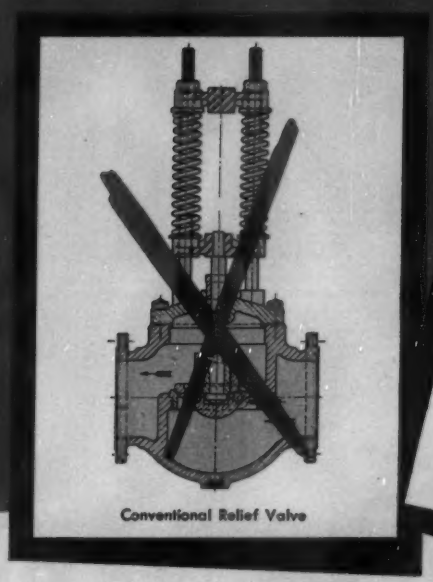
131

CONTROLLED QUALITY MEANS QUALITY CONTROLS

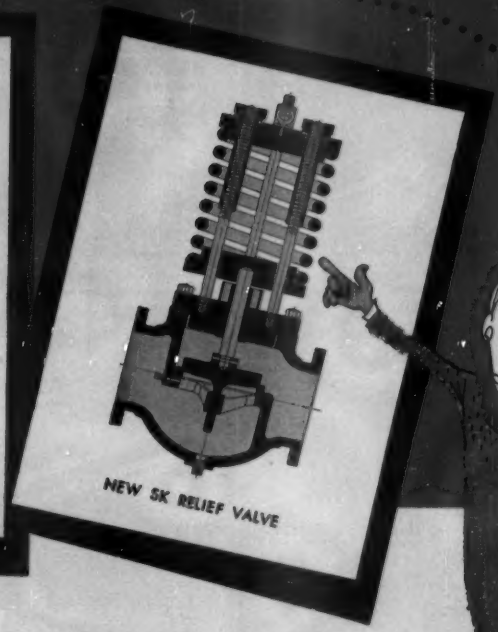
For more data circle 543 on Post Card

NOTICE ANYTHING UNUSUAL ABOUT THIS RELIEF VALVE?

ITS NEW FEATURES ARE TYPICAL EXAMPLES OF SK ADVANCED DESIGN



Conventional Relief Valve



NEW SK RELIEF VALVE

Look again . . . at the diagram of the conventional relief valve and the new SK Relief Valve beside it. Note the uncommon features of the SK Valve . . .

. . . Single Spring Construction. This eliminates the cumbersome, unstable superstructure of conventional, multiple-spring relief valves.

. . . Large Coil Diameter and Heavy Spring Wire Cross Section. This provides maximum spring stability; there is the least possible difference between pressure needed to unseat the valve and that required to force it full open.

. . . Valve-Spindle Guides Both Above and Below Valve Disc. These assure accurate seating and permit the use of valve in any position and its installation in vertical or horizontal pipelines.

. . . Reduced Over-all Height Through the Use of Reach Nuts. This eliminates long spring rods and permits the use of rods which do not extend beyond the upper spring plate after compression.

BUT THIS IS NOT ALL!

Right now—while you read this—new products and improvements are taking form on our drafting boards, and others are being third-degree'd in our research and testing laboratories. We call this "Progressive Design"—a job at which we excel because we have the staff, the background, the ability and the facilities to deal with the toughest problems. We invite you to prove this. If a design puzzle has you frustrated, bring it to us. No obligation, of course.

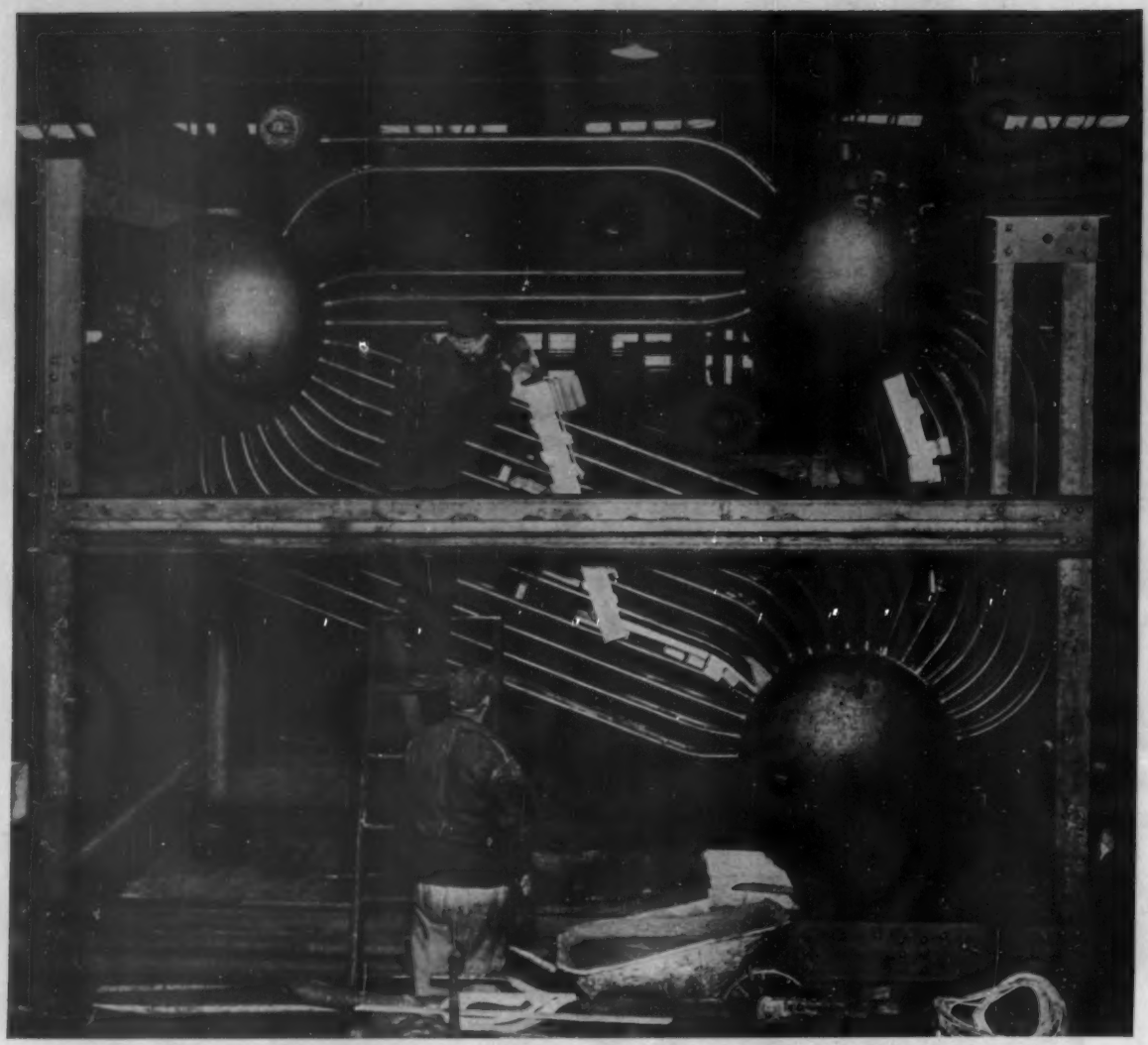
Send for further information on SK's new Relief Valve to the address below.

Schutte and Koerting
COMPANY
MANUFACTURING ENGINEERS

3221 STATE ROAD, CORNWELLS HEIGHTS, BUCKS COUNTY, PA.

Jet Apparatus • Heat Transfer Equipment
Strainers • Condensers and Vacuum Pumps
Oil Burning Equipment • Rotameters
Flow Indicators • Radiafin Tubes • Valves
Spray Nozzles and Atomizers • Gear Pumps
Desuperheaters

For more data circle 544 on Post Card



Monolithic, gas-tight baffles of refractory concrete are easily made with a castable refractory and simple form. Packaged castables used on this job were made by Mexico Refractories Company, Mexico, Mo.

CASTABLES: Fast, Reliable, and Easy to Use

Here's a quick, easy way to handle power-plant refractory installation and repair jobs. Just add water to a prepared castable containing Lumnite* cement, mix, and you're ready to place refractory or insulating concrete. Ideal for lining steel stacks, breechings, boiler walls, doors, coal bunkers, and ash pits. Saves time and cuts costs because concretes made with Lumnite reach service strength within 24 hours.

Castables are packaged mixes of Lumnite calcium-aluminate cement plus aggregates selected for specific temperature and insulation needs. Because they are pre-mixed and ready to use, castables minimize chances for error. They are made and distributed by leading manufacturers of refractories. Keep a supply in your plant at all times. Especially handy for emergencies.

You'll find many uses for industrial concretes made with Lumnite cement throughout your plant. Write today for more information on where and how to use them.

UNIVERSAL ATLAS CEMENT COMPANY

UNITED STATES STEEL CORPORATION SUBSIDIARY

100 PARK AVENUE, NEW YORK 17, N. Y.

Albany • Birmingham • Boston • Chicago • Dayton • Kansas City
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*"LUMNITE" is the registered trade-mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.

PE-L-178

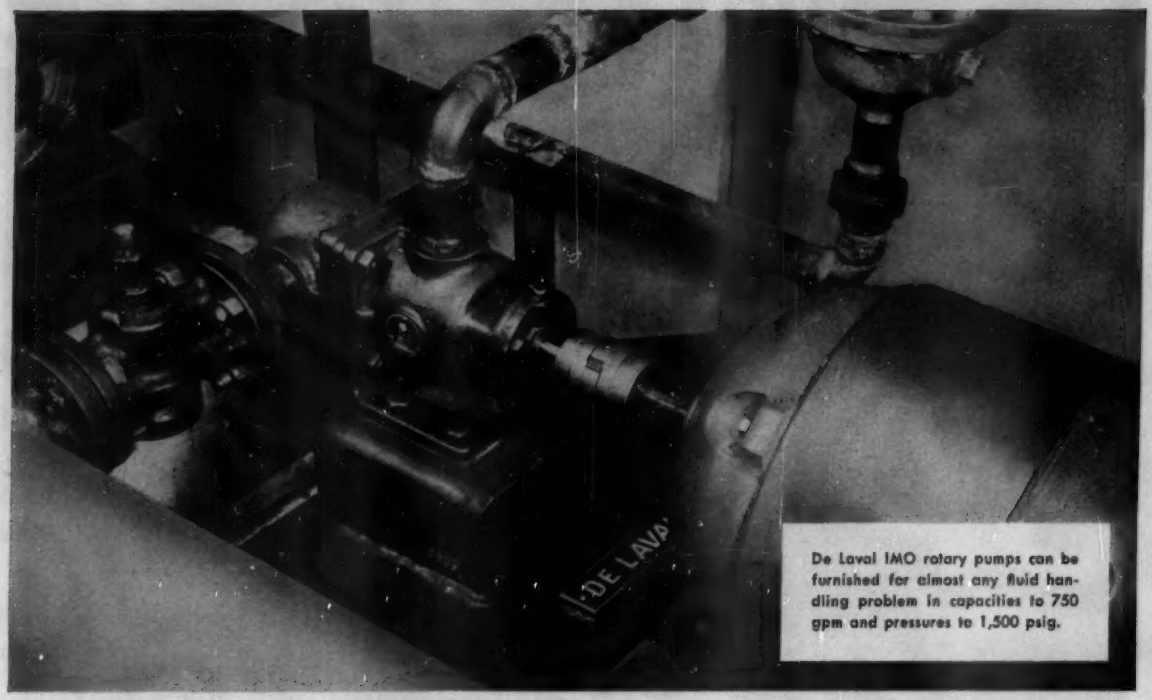
Atlas® Lumnite Cement

FOR INDUSTRIAL CONCRETES

REFRACTORY • INSULATING • OVERNIGHT • CORROSION-RESISTANT

UNITED STATES STEEL HOUR—Televised on alternate Wednesdays—See your local newspaper for time and station

For more data circle 545 on Post Card



De Laval IMO rotary pumps can be furnished for almost any fluid handling problem in capacities to 750 gpm and pressures to 1,500 psig.

What to Look for in a Rotary Screw Type Pump

By W. J. MONGON, *Assistant Chief Engineer*
De Laval Steam Turbine Company

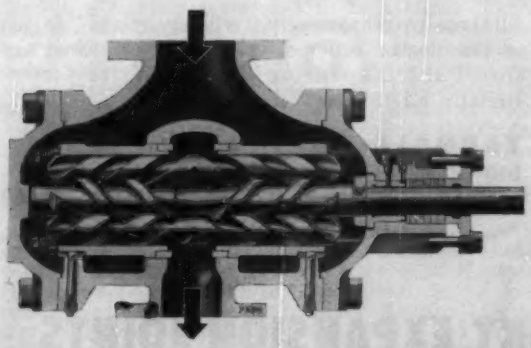
A sound knowledge of design, and how it affects performance, is the best insurance a buyer can have that he will get the pump he needs. This brief analysis of the IMO, a rotary three-screw pump manufactured by the De Laval Steam Turbine Company, will give you some of the necessary facts.

What qualities should you look for in a rotary type pump? It must, of course, meet specified capacities and pressures. But, it must also be efficient, operate quietly, stay on the job.

The axial flow of a screw type pump, and the resulting low inlet losses for any given pump speed, are important benefits that should be considered in making pump selections. The absence of timing gears and other mechanical features of construction also enable the De Laval IMO pump to operate at direct-connected motor and turbine speeds . . . to handle viscous liquids and high suction lifts.

One of the most important features of the IMO pump is the hydraulic turning of the idler or sealing rotors. The central or power rotor is the pumping element; the liquid pumped turns the sealing rotors.

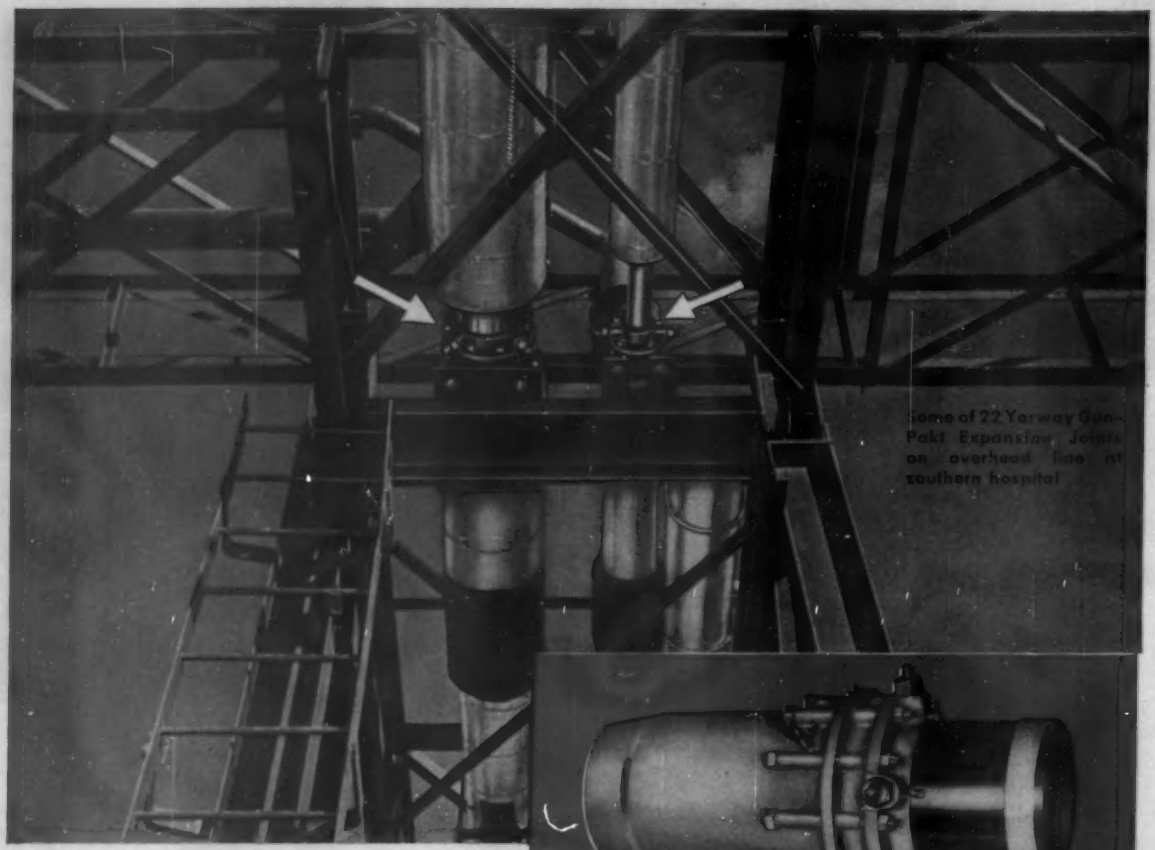
A screw type pump is well suited for applications where pulsation-free flow is desirable. The axial flow of the liquid without trapping and the unique thread form which keeps closures fluid-tight contribute to quiet operation of the IMO pump.



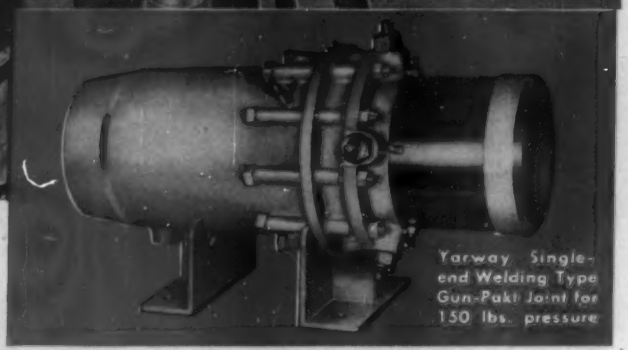
De Laval IMO Series A322A, a positive displacement, rotary screw type pump, can handle capacities to 750 gpm and pressures to 150 psig.

Catalog LS gives useful application and specification data on the IMO pump. An article titled, *Rotary Pumps, Basic Considerations in Their Application*, contains a description of rotary pumps in general. For these publications, write on your company letterhead to De Laval Steam Turbine Company, 816 Nottingham Way, Trenton 2, New Jersey. DL-301

For more data circle 546 on Post Card



Some of 22 Yarway Gun-Pakt Expansion Joints on overhead line at southern hospital



Yarway Single-end Welding Type Gun-Pakt Joint for 150 lbs. pressure

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Fig. 1. Texas Natl. Bank, for which two separate electrical systems were designed

Here's Proof of 480 V Distribution Savings

Two separate electrical designs, one for 480, the other for 120 v distribution, were made for new Texas National Bank Bldg., thus providing unusual opportunity to compare costs for two systems

TODAY'S LARGE modern office building is a relatively large user of electric power. It's electrical demand may run from 1500 kva for a small building of five to ten stories to 6000 kva for a large building of 30 to 40 stories. Years ago, the electrical load in a building averaged 1 to 2 volt-amperes per sq ft; today a modern building will run from 5 to 10 volt-amperes per sq ft with this increase expected to continue. Loads of this size thus put a modern office building in the same category as many of our industrial plants which may average 5 to 15 volt-amperes per sq ft in electrical loads.

With this kind of power the size and cost of the distribution system components become appreciable, and with the electrical power system representing approximately 5 to 12 per cent of the total building cost there is a growing incentive to reduce the installed cost of the electrical system.

One of the most effective ways of reducing the size and cost of electrical equipment is to distribute at a higher voltage, and today architects and engineers are examining closely the use of 480 Y/277 volt power systems instead of the present conventional network voltage of 208 Y/120.

It is one thing to say generally that a higher distribution voltage gives a reduced installation cost, but it is another to prove it in dollars and cents. An unusual opportunity to provide this proof occurred recently in connection with the new Texas National Bank Building now being constructed in Houston, Texas. This is a 20-story office building costing $11,000,000, and the electrical system for the building was first designed for 208/120 v service since this was the available voltage in the downtown area of Houston where the building was to be located. However, the Houston Lighting and Power Company had for some time been studying the question of supply voltages in their network area, and sometime after the 208/120 v system had been designed for this new building the power company completed their studies and offered to supply a 480/277 v service for the building if the owners desired it. A preliminary investigation suggested there would be substantial savings with this higher distribution voltage and so it was decided to redesign completely the electrical distribution system for 480/277 v to find out what the savings would really be. In this manner installed costs of the same power system at each voltage became available and they can be used to measure accurately the cost differences of the two systems.

The building is 122 ft by 253 ft. It consists of 20 floors above street level with two floors below street level. The connected electrical loads for the building are shown in Table I. They total nearly 6700 kva and give an electrical load of 6.2 volt-amperes per sq ft for the building.

Comparison of Systems

Table III summarizes the cost changes when the system was redesigned for the higher voltage. Here are brief explanations for each item.

Switchboards, Panels and Bus Duct: Table II compares the quantity and sizes of these items for the two voltages from which it can be seen that substantial reductions are possible at 480 volts. This equipment at 208 volts was quoted at $245,000. The same equipment for the 480 volt system was quoted at $170,000, giving a $75,000 saving. This is the principal saving realized in the redesign of the system from 208 to 480 volts.

Transformers: The 208 volt system did not employ transformers in any way. However, the 480 volt system required some transformers to transform miscellaneous power from 480 to 120/240 for convenience outlets and such incandescent lighting circuits as were required. The contractor's estimate for these transformers was $27,000, which was an additional expense for the 480 v system for equipment of a type which was not required on the 208 v system.

Less Wire on 480 V

Conduit and Wire: A considerable saving in cost was realized in conduit size and wire size by the change from 208 to 480 v distribution system. Apart from the reduction in wire size, less wire was required on the 480 v system since more fixtures could be used on a lighting circuit resulting in fewer home runs.

Lighting Fixtures: In general all the incandescent fixtures on the 208 v lighting system were reemployed in the 480 v system in the same spaces. The fluorescent fixtures were used in the same spaces but generally all fluorescent fixtures were changed to 277 v equipment. The 277 v fluorescent lighting fixtures cost appreciably more than the same fixtures at 120 v. The total fixture cost for the 208 v distribution system was $233,500 and the total cost of

Table I. Bldg connected electrical load

Type of Load	Connected KVA	% of Total
Air Conditioning	1940	29
Elevators	415	6
Pumps and Misc. Motors	1230	19
General Lighting	2960	44
Exit and Emergency Lighting	144	2
Total KVA	6689	100

Table II. Shows differences in the equipment required for 208 and 480 v systems

Breakers		Feeders		Switch and Fuse Type Switchboards	
208 Volts	480 Volts	208 Volts	480 Volts	208 Volts	480 Volts
2-6000 amp	2-4000 amp	2-6000 amp *	2-4000 amp *	1-800 amp	1-400 amp
3-2000 amp	3-1000 amp	3-2000 amp *	3-1000 amp *	5-400 amp	5-200 amp
1-1600 amp & 1-1200	1-1200 amp	1-2C00 & 1-1600 amp *	1-1600 amp *	7-200 amp 1-400 & 1-200 amp	7-100 amp 1-200 amp
3-1500 amp	3-1000 amp	2-1500 amp * & 5-500 MCM	2-1000 amp * & 500 MCM	1-200 & 1-100 amp	1-200 amp
1-1600 & 1-1200 amp	1-1000 amp	1-2000 & 1-1600 amp *	1-1600 amp *	2-200 amp	1-200 amp
1-800 amp	1-800 amp	3-500 MCM	3-400 MCM	1-200 amp	1-60 amp
1-1200 amp	1-400 amp	4-500 MCM	3-500 MCM	2-100 amp	2-60 amp
1-800 amp	1-300 amp	2-500 MCM	1-500 MCM	2-100 amp	2-100 amp
2-400 amp	2-200 amp	4-500 MCM	2-500 MCM	1-200 amp	Deleted
Switches					

* Bus Duct Feeders

Table III. Shows the difference in material and labor costs for the two systems

Item	Material	Labor	Net Change
1. Switchboards, bus duct and panels	−$69,583.00	−$5,451.00	−$75,034.00
2. Transformers, circuit breakers and safety switches	+ 17,315.00	+ 9,737.00	+ 27,052.00
3. Conduit and wireway	− 4,293.00	− 4,606.00	− 8,899.00
4. Wire	− 26,434.00	− 1,180.00	− 27,614.00
5. Locknuts and bushings	+ 592.00	—	+ 592.00
6. Pull boxes	+ 1,172.00	+ 637.00	+ 1,809.00
7. Hangers and cable supports	− 1,452.00	− 68.00	− 1,520.00
8. Lighting fixtures and lamps	+ 27,619.00	+ 122.00	+ 27,741.00
9. Boxes and devices	− 1,066.00	− 1,600.00	− 2,666.00
10. Q and underfloor duct	+ 315.00	+ 114.00	+ 429.00
11. Cold cathode lighting and misc.	+ 2,698.00	+ 2,766.00	+ 5,464.00
12. Telephone, clock, and Muzac	+ 798.00	+ 292.00	+ 1,090.00
13. ADT, signal and misc.	+ 426.00	+ 1,310.00	+ 1,736.00
Total Net Changes	−$51,893.00	+$2,073.00	−$49,820.00

fixtures for the 480 v system was $261,200. This cost increase was due mainly to an increase in price of $1.40 for the fluorescent lamp ballasts at this high voltage. There are two ballasts per fixture and there are 10,000 fixtures included in the job. Thus the total increased cost is approximately $28,000. This estimate was made at the beginning of 1953. If it were made today it would be expected that the difference in cost between the two types of fixture would be very little. Thus the savings for the higher voltage would be increased by nearly this amount of $28,000.

Miscellaneous Items

Devices, Boxes and Plates: Quite large changes were made in the number of devices, boxes and plates for the 480 v system as against the 280 v one. The 208 v system required 1290 wall switches whereas the 480 v system required only 980. The contractor's estimate for the devices, boxes and plates was $13,600 for the 208 v system and $11,000 for the 480 v.

Applicability of the 480 Volt System: Many factors determine the amount of savings for a 480 v system. First and most important factor is whether a 480 v service is available from the power company. If only 208 v power is available it is possible to buy auto-transformers to step the voltage up inside the building. Although these auto-transformers cost about $8 per kva it is still possible to effect a substantial saving even if they are included.

Perhaps the largest factor which determines the amount of saving is the configuration of the building. The greatest saving can be made when the area per floor is small compared with the number of floors. This is due to the fact that the large saving is made in the size of cable and bus duct used in the risers of the building. Had this particular building been 40 stories in height rather than 20, the saving would likely have been substantially higher per kva.

120/480 V Load Ratio Important

The ratio of 120 to 480 v load is another important factor. This ratio on the Texas National Bank Building was 1 to 18 which is 6 per cent of the total or a load of ⅙ volt ampere per sq ft. In general, where this range will be ½ to 2 volt ampere per sq ft the cost of the 480 v transformers will take up only a small part of the over-all savings of the rest of the system. As the ratio increases however, and more 120 v transformer capacity is required then savings favoring the 480 v system are decreased.

Another significant factor effecting the over-all savings is the type of occupancy of the building. If there should be many small tenants per floor occupying only a room or two then each had to supply his own lighting fixtures the 208 v system would be favored since a tenant ordering 277 v fixtures in small quantities would find the cost considerably higher. But when a few tenants occupying large areas where large quantities of fixtures can be bought by the building owner, then the savings on the 480 v system go up.

The main factors accounting for the savings in the 480 v system have been large general area lighting loads and large central air conditioning systems. Actually the idea of higher distribution voltage systems which result in savings is not limited to office buildings. It may frequently be applied with success in schools, hospitals and modern shopping centers. If there are large general area lighting loads, large central air conditioning systems and particularly long cable or bus runs the chances are that a detailed study of the power system at each voltage will show that there is a potential saving in the 480/277 v system. This has been the story of one building in which it was proved.

The information in this article is taken from an AIEE Paper presented at Los Angeles, Calif., by W. W. Henderson, Bernard Johnson & Associates, Houston, Tex., and H. N. Hickok, General Electric Company, Houston, Tex.

New Unit Produces Magnesium from Sea

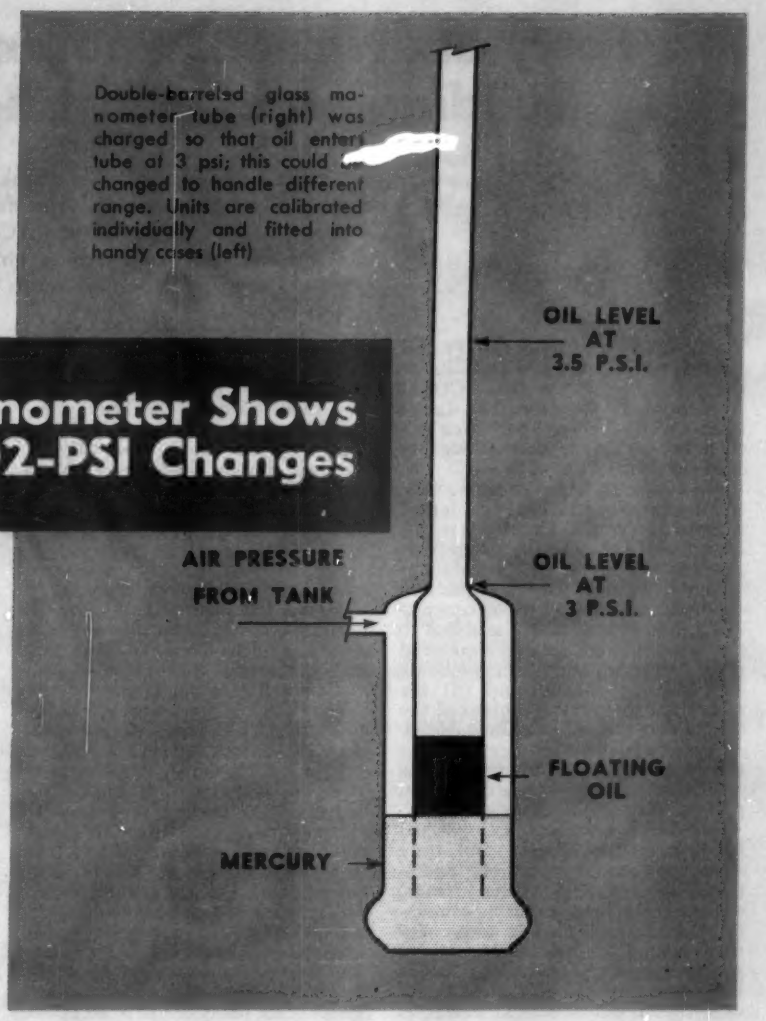
DOW CHEMICAL COMPANY has ordered a 50,000-kilowatt steam turbine-generator from the Lynn plant of General Electric Company for its Freeport, Texas, plant, which produces magnesium extracted from seawater and a variety of other inorganic and organic chemicals. The unit will be used to produce both process steam and power.

Total steam flow of the double-automatic-extraction unit will be almost 1,000,000 lb of steam per hour. Each of its two extraction openings will be capable of putting out 400,000 lb of steam per hour, almost double the normal flow on a preferred standard 44,000-kw machine.

The turbine for this powermaker will operate at a throttle pressure of 1250 psi at a temperature of 950 F. Steam will be extracted out at 475 psig and 235 psig. Generator is rated 3 phase, 60 cycles, 14,400 v., 30 psig hydrogen cooled.

Double-barreled glass manometer tube (right) was charged so that oil enters tube at 3 psi; this could be changed to handle different range. Units are calibrated individually and fitted into handy cases (left)

Compact Manometer Shows 0.002-PSI Changes



RYAN Aeronautical Co. has devised a unique, new pressure gage which is ingeniously designed to blend sensitivity with compactness. It is so sensitive that it will indicate pressure changes of only 1/500th of a pound per square inch. It is simple and fool-proof to use and only 18 inches tall.

Conceived by Win Alderson, of the instrument laboratory, the new instrument is a two-fluid manometer, tailored for pressure-testing the huge external fuel tanks which Ryan builds for Boeing KC-97 Stratofreighters. Its basic design could be used for a variety of other pressure measuring tasks.

For several years, Ryan has built large aluminum fuel tanks which must be absolutely leak proof. To insure their fuel tightness, these aluminum cells are pressure-tested by subjecting them to a pressure of 3.5 psi for 45 minutes. During this extended interval, even slight leaks will be evidenced as a drop in pressure in the compressed air held in the tanks.

To detect these slight pressure changes, Ryan production needed a sensitive type manometer. Originally, water manometers were built and used. Water possesses the correct specific gravity for indicating slight pressure changes with good visibility in a manometer tube. One pound per square inch of pressure will support a column of water of about 27 inches high and this length of column can be calibrated into a sensitive barometric gage.

But, to get pressure readings which range between three and four psi, the water column had to be 10 feet tall and this was an extremely unwieldy instrument to use. Employees had to climb a stepladder to check readings. Equipment was difficult to move and the evaporation of the water was a constant factor to be contended with.

On the other hand, a mercury manometer would not show the very small pressure changes which might occur. Weighing 14 times as much as water, a column of mercury of less than two inches is supported by a pressure of one pound per square inch.

Production necessity is often the mother of laboratory invention. This was no exception. Win Alderson, and other technicians in the Ryan instrument laboratory, solved the problem by using both mercury and a light oil in an ingenious combination. The Ryan sensitive manometer consists of a glass capillary tube blown with a larger-diameter open reservoir at one end. This reservoir is inverted and placed within a closed glass container, which is attached to the pressurized tanks by a rubber tube.

Two liquids are poured into the glass container: mercury and manometer oil, which is dyed red for better visibility. The oil has the same specific gravity as water and has practically zero coefficient of evaporation. The oil floats on top of the mercury, which is 14 times heavier.

The amount of mercury used is carefully measured so that when a pressure of three psi is impressed on the system, the oil, floating on top, will be raised to the opening of the small capillary tube. As the pressure rises above three psi, the red oil shoots up the tube at an accelerated rate of 27 inches per psi. This presents the viewer with a readily observed indication, even for pressure changes of as little as 0.002 psi.

Another advantage of the manometer oil is its sharply defined meniscus which is much easier to read than the wider formation at the top of a water column. Ryan has calibrated the sensitive manometers with master instruments, so that very small pressures can be determined. In the tank applications, however, only pressure *changes* are important. By varying the design of the glassware, this manometer could be especially tailored to meet a wide variety of instrument requirements.

Forty-Six Nations Pool Information on Building and Operating Large Dams

When an engineer makes a mistake in the design, construction, operation or maintenance of large dams, it is seldom a small mistake. That is why the Fifth International Congress on Large Dams was held in Paris this year, and that is why 1024 thought it necessary to attend. Dams built in the future will show the ICOLD influence

LAST May and June the French National Committee on Large Dams was host to the Fifth ICOLD (International Congress on Large Dams). This unique gathering included the top hydropower designers of 46 nations.

Four subjects were discussed at the technical sessions held in Paris June 1 through June 3. They were: (a) Design and construction of dams on permeable soils and methods of foundation treatment; (b) economics and safety of different types of concrete dams; (c) settlement of dams due to compressibility of the dam's material or of the foundation soil, including earthquake problems; and (d) the relation of the cement content of the concrete to performance in practice of gravity dams (interior and exterior), arch dams and buttress dams — and the influence of this cement on permeability and frost resistance.

The first subject was distinguished by reports from France and Italy concerning grouting practices used in permeable soil foundations. France, especially, reported grouting foundations several hundred feet deep under dams several hundred feet high, using pressures up to 700 psi with a mix of extra-fine cement, clay and chemicals. United States delegates suggest that there are several sites in the U. S. which might make good use of this practice.

New rules for accommodating indeterminate factors were advanced by the French and Italians during the second discussion. Arch dams, for example, were once considered feasible if the length of the dam were less than four times the depth; now it is recommended that this be increased to a ratio of less than seven times the depth. This second discussion session also brought reports of the testing of both site and dam models by the Portugese.

The third session, devoted to settling of dams and their foundations, brought forth several suggestions that foundation materials be tested in place. Instrumentation of dams to permit observation of their performance after completion was urged. These subjects are very important because of the increasing number of poor dam sites that must now be employed.

Little new information was forthcoming from the last session, which dealt with concrete for large dams.

Two technical tours were conducted before the sessions began and, while they took different routes, they overlapped at the heavily industrialized Rhone River and the Serre-Poncon earth dam on the Durance River. This area was of considerable importance because of the extensive efforts to harness the Donzere-Mondragon fall. The Donzere-Mondragon power plant is the largest on the Rhone, generating about 2,000,000,000 kwh per year. A second fall near Montelimar will generate some 1,750,000,000 kwh per year. Locks at Donzere (86-ft lift) and Montelimar (63-ft lift) keep traffic moving on the Rhone.

Tour "A" started with a visit to the Alsthom plant at Belfort, France (they make locomotives, power and electronic equipment), and then went on to the new developments on the Rhine. From the Swiss border to Strasbourg, the Rhine is being smoothed out with a 70-mile-long canal designed to carry 38,000 cfs at 4 fps (max.). Besides a navigational project, the canal will comprise a 6,000,000,000-kwh per year power development. From the Rhine, Tour "A" moved on to the Rhone, then to other French engineering projects. Space does not permit a complete record here.

Tour "B" visited the same type installations as Tour "A", and again space prohibits much discussion. One installation is extremely interesting, however, because of the cost implications. Gage Dam on a tributary of the Loire River stands 125 ft high and is only 12½ ft thick at the base. It is only 4¼ ft thick at the top. Stresses of 1425 psi were used in the design whereas a similar arch dam in the same system allowed only 640 psi.

Couesque Dam on the Truyere River exhibited another saving of concrete. Here the top of the thin arch dam overhangs the base by leaning downstream, with the result that water pressure acts downward on the dam as well as horizontally. This increases the dam stability and improves the seal between horizontal construction joints. Height of the dam is 196 ft and the power plant is 980 ft below the dam.

North African Tours

Technical tours through North Africa followed the Paris meeting. Much good engineering was in evidence there where water was hard to find and conservation was essential. Dams in this region must also serve for flood control.

Ingenuity was displayed in the construction of the Ben-Metir Dam (Barrage de Ben-Metir) in Tunisia, which contributes to the water supply for the City of Tunis. Instead of forms, this round head buttress dam was cast in precast concrete slabs. These were left in place to comprise a very dense concrete surface.

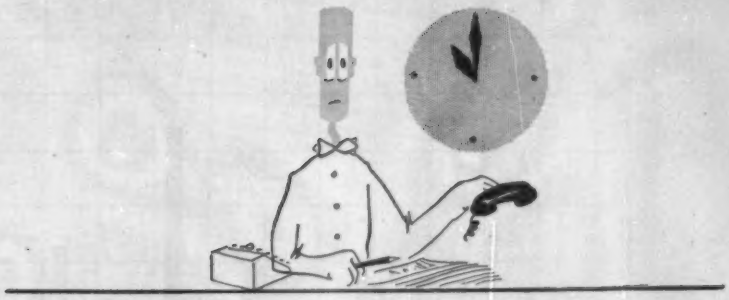
United States delegates felt that our nation was inadequately represented on these tours and at the Congress sessions. Surely more engineers could find the time and financing necessary to attend such meetings being held overseas. Reports from this one indicate much information is to be had for the asking, and that overseas hosts are extremely cooperative.

NOTICE

COPIES of the Proceedings of the Fifth International Congress on Large Dams are being prepared in Paris at this time. You may obtain copies in this country from:

Gen. Stewart E. Reimel, Secretary-Treasurer
United States Committee on Large Dams (PoE)
Engineers' Joint Council
29 West 39th Street,
New York 18, N. Y.

No prices are yet available on these reports, but they have been about $50 in the past. There is a possibility of delay in filling orders not placed in advance since the above agency does not keep large stocks on hand.



COST ESTIMATING MUST BE DONE RIGHT

. . . . . and here's how to go about it. Two specialists from Diamond Alkali Company tell power engineers how to make tough job easier

THE AUTHORS

J. W. HACKNEY

Now Chief Construction Engineer, Hackney was employed by Diamond to supervise the construction of Houston Works in 1946. Formerly with Alcoa, he is graduate of Carnegie Tech

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Robertson has been Project Engineer at Diamond since 1952, now with process plant design duties. He has been with the company 5 years, and received a BS in Mech. Eng. from Carnegie Tech

COST ESTIMATING is an attempt to forecast the future. Actually, of course, it is an attempt to predict the final cost of a project by creating in the mind or on paper an image of the completed project, considering the dollar cost of similar construction in the past, and taking into account the effects of the multitude of factors which will probably influence the course of the project during construction. The man who undertakes this venture willingly and eagerly is either very bold and experienced, or very inexperienced.

But future costs must be estimated. No project should be begun without knowing, at least reasonably well, its probable final cost. If the project is to be built by a contractor for a fixed price, he will make or lose money in strict accordance with the accuracy of his estimate. If the estimate is for the use of the project's future owner, it is the basis for his decision to approve the project because it will make enough money to justify the investment, or to drop it because other projects are better. Even if the investment amount should be unimportant, relative to some extremely beneficial result to be obtained, a cost estimate provides a means of orderly planning for manpower and money. It is also a yardstick by which efficiency can be measured, and costs controlled.

For the contractor who submits a fixed-price bid on a project, either an excessively high estimate or an excessively low estimate is equally disastrous. If he bids too high, he loses not only the job, but also his cost of preparing the estimate and bid. If he bids too low and gets the job, he may lose everything by bankruptcy, or by the slower process of being tempted into shoddy workmanship and sharp practice.

For the project owner, excessively high or excessively low estimates contain more subtle but no less dangerous pitfalls. If an estimate is extremely high, a project which could have been a good, paying investment may never be built — and good projects are hard to find. Even the national economy is so affected; any project earning a fair return for its owner must simultaneously earn an equal or greater amount for the federal government.

Estimate Can Be Yardstick

If an estimate is higher than it should be, but not so high as to kill the project, the estimate has no value as a yardstick of efficiency in designing and building the project. There is usually less rigid control of costs during design, and those extras which would be "nice to have" may be added without thoroughly checking their economic justification. During construction in the field, less attention is paid to costs when they are

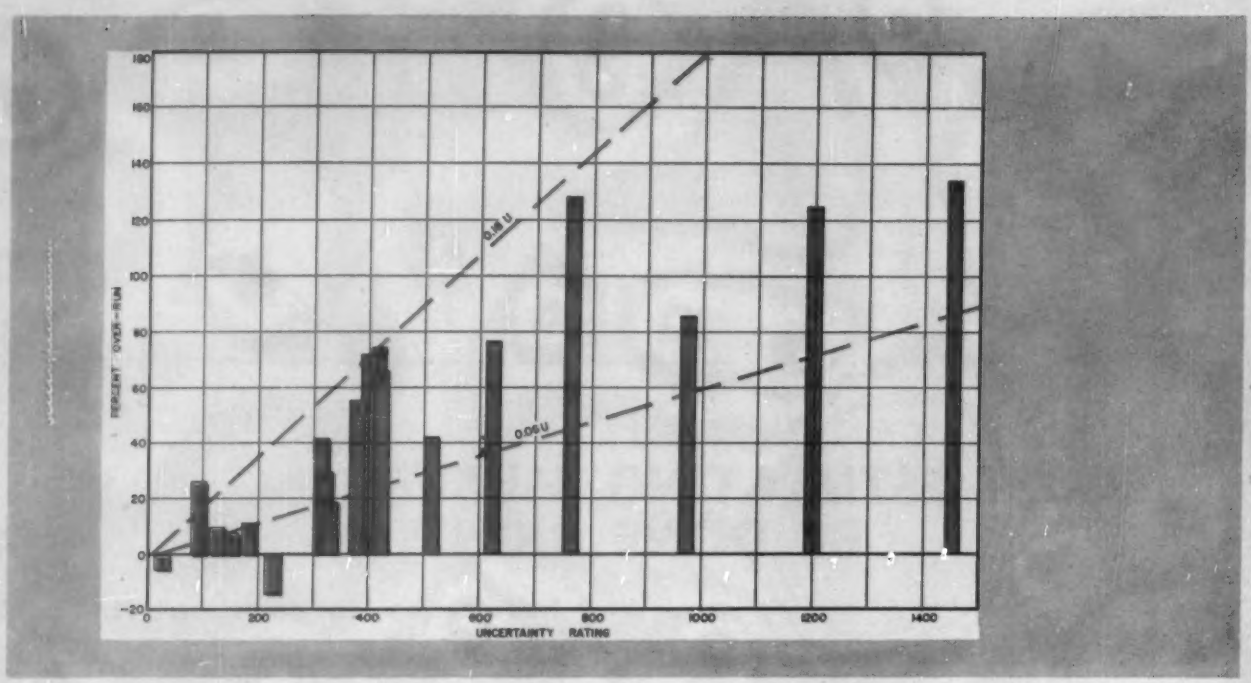


Fig. 1. Plot of estimated versus actual costs for four projects shows how degree of definition affects accuracy. Estimates at right on the graph are "quickies"

running well under the estimate. Inefficiency is less likely to be noticed and eliminated.

On the other hand, if the estimate is very low compared to the actual cost, the owner may run out of money before the project is finished. Since more than the expected amount of money and manpower will be required, there is also a good chance that, even if the necessary money can be found, the project will take longer to complete than if its size had been appreciated from the first and plans made accordingly. The resulting start-up deferment can cause loss of income and customers. Finally, the project may turn out to be a money-loser, or at best a marginal project, using investment funds which could have produced more income elsewhere.

Like an overly-high estimate, a very low estimate also ceases to be a yardstick of efficiency for design and construction as soon as it becomes obviously unrealistic. Up to that point, strong efforts will be made to keep the project's cost within the estimate. When this becomes a complete impossibility, the estimate becomes valueless as a control. The value of future estimates made by the same group is also impaired, since there will be a tendency to disregard them as "unrealistic" on the basis of previous experience.

From the preceding it is apparent that estimates should be accurate. But let's face it; an estimate is a forecast of the future. Although we cannot hope for perfection, we can try to attain the best accuracy possible under the circumstances, and do our best to understand the possibilities, under the circumstances, of over-runs and under-runs.

Factors Affecting Accuracy

The accuracy of an estimate is a function of variables which can be grouped as follows:

1. Degree of definition of the project;
2. Accuracy of the forecast of conditions during design and construction;
3. Quantity, adaptability and accuracy of cost records available to the estimator;
4. Estimating method used;
5. Skill of the estimator.

Definition of the project is basic. If it is to be a power-house, where is it to be built? How much electrical power? What voltages? How much steam? What pressures and temperatures? Outdoor-type installation or monumental architecture? What fuel? How will it be delivered? Are flow sheets available? Have detailed drawings been prepared?

The degree to which the definition of the project has developed, as indicated by the answers to these and similar questions, will powerfully affect the accuracy of the estimate. For example, if all of the detailed drawings for a power plant are complete, a bid-type estimate of excellent accuracy is possible. If only the proposed electrical output is known, the estimate can be only a rough approximation. Intermediate degrees of definition produce intermediate degrees of potential accuracy.

Next comes the forecast of the conditions under which the project will be built. Will construction be by lump-sum contract? By plant personnel? At cost-plus-fee? Who will be field superintendent? Will the project be built in the summertime? (If it's to be built in Minnesota, that's good; if Alabama, that's bad.) What rates will be paid? How much travel pay? Are there plenty of good mechanics to choose from, or will this job have to take the dregs left over from nearby projects paying big overtime. Obviously the estimator is going to have a tough time forecasting these job conditions and their effects on cost. He will have less trouble, however, if he is fortunate enough to be estimating for a single contractor doing one type of work in a limited geographical area.

As to cost records, two things can be said. The first is that good cost records cost money. The second is that good

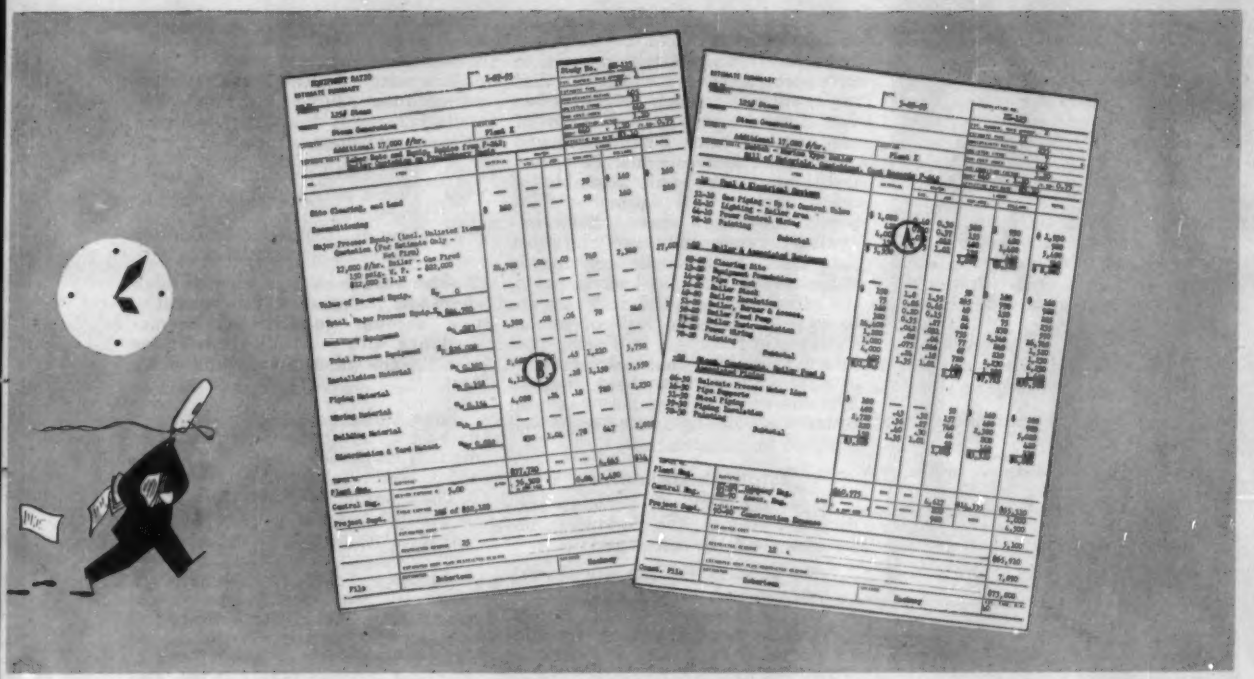


Fig. 2. Preliminary-Bill Method (a) is less accurate than detailed estimate, but prepared in one-fourth the time. Equipment-Ratio Method form shown in (b)

cost records (good, that is, from an estimator's point of view) need cost no more than poor ones. In these days of income taxes, payroll taxes, and audited corporate reports, every construction transaction must be recorded in detail. To make these records useful to the estimator, it is only necessary that the data be classified and grouped in a consistent way, and that the groups be basic project elements which can be adjusted and assembled to build up the probable cost of a new project. Cost accountants are usually eager to see their records used to the greatest possible advantage in planning new projects. With a skillful accountant's help, construction costs can be reported in such a manner as to be most helpful to the estimators, without increasing the cost of their preparation.

Having a project definition, a forecast of construction conditions, and cost records at hand, the estimator selects his estimating method. If complete drawings and detailed cost records are available, he can make a detailed estimate — if he has enough time. If he lacks time, or the necessary details, then he must use one of the ratio methods. There are several of these, each having an accuracy proportionate to the degree of detail it includes. We will discuss this further in connection with improving estimate accuracy.

Finally, we must consider the estimator. Ideally, he is a paragon of the engineering virtues — accurate, cool under pressure, careful of detail, gifted with imagination, having an engineering degree, accounting experience, two or three years in design, two or three years in construction, and four to five years as understudy to an experienced estimator. Since such men are rare — perhaps nonexistent — the skill of the estimator must be considered as a factor in establishing the probable accuracy of an estimate.

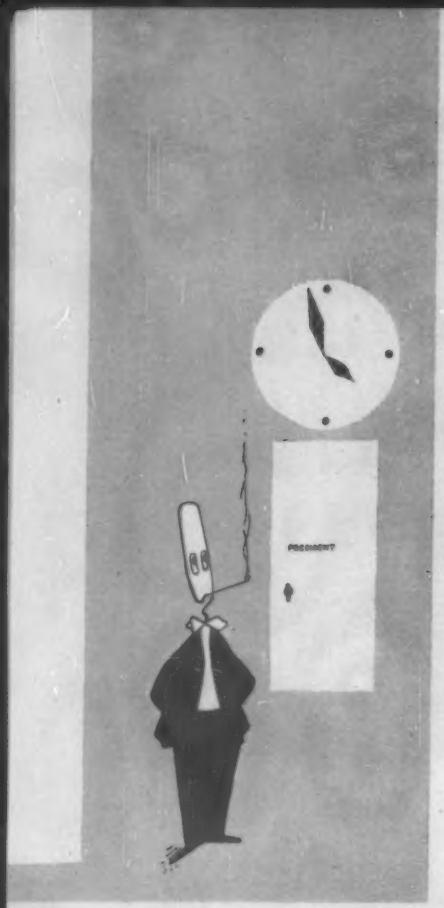
Exact Estimates Unlikely

It should be apparent from the preceding discussion that pin-point estimate accuracy, except on a chance basis, is unobtainable. Actual costs will over-run or under-run estimates. If estimates are made for a series of projects, it has been found by experience that these over-runs and under-runs will form a dispersion pattern — a pattern similar to that obtained by firing a rifle at a target. Under the best conditions, the estimate pattern will be narrow; narrow enough that contractors are willing to gamble lump sum bids on the results. Under poorer conditions, the pattern will be wider.

It has been found that the dominant variable determining the spread of this estimate dispersion pattern is the degree of project definition. In other words, it helps to know what you are shooting at, whether you're using a rifle or a slide-rule.

In Fig. 1 are plotted the percentage over-runs and under-runs which might be expected for a series of estimates made for large projects with various degrees of completeness of project definition. For consistency, all contingency allowances should be eliminated in plotting a diagram of this type. While the points will be scattered, which is not surprising considering the many variables involved, there will be a definite pattern of increase in over-runs, and increase in scatter of points, for the projects which are least completely defined at the time of estimate. Projects one through four of Fig. 1 show the effect of improvement in definition as successive estimates are made for single projects. It should be understood that the estimates toward the right of the diagram are definitely of the "quickie" variety. In general only those with a rating in the "zero to one-hundred" range are based on detailed drawings. A diagram of this type can help provide an answer to the question, "How accurate can an estimate be — under existing circumstances?"

When we see a plot of estimated against actual costs like the one referred to above, we get a picture of



the vagaries of actual costs, but we also feel the need for improving our estimating methods. This is especially true for estimates which due to press of time cannot be made by a conventional "contractor's take-off" from complete detailed drawings.

The estimator has at his disposal many basic estimating principles. Some of these generalized principles by which estimate accuracy can be approached will be reviewed in succeeding paragraphs, with some illustrations of their practical application. In broad terms, these general principles are:

1. Subdivision of cost records into physical units which will recur in future projects;
2. Adjustment of cost records to current prices;
3. Establishment of cost-capacity relationships for similar units;
4. Standardization of a series of estimating methods to fit varying degrees of project definition at the time of estimate;
5. Pre-computation of estimating data;
6. Use of a "target" estimate for design and construction;
7. Establishment of a "restricted reserve", indicating the accuracy range of the estimate and permitting appraisal of the effect of the maximum probable over-run on the success of the project.

The cost estimate for a modern industrial plant involves so many features that it is absolutely essential to have some means by which the vast welter of detail can be organized so that it can be worked with. Cost of past projects must be collected and identified. These costs must be stored, and they must be easily available for use in making new estimates. This points towards a standardized numerical system of classifying cost data. Such a standardized system is indispensable if the field accountants, the estimators, and the designers are to have a common basis of understanding in recording and using cost information. Many such account subdivision systems have been devised. The one which is used here has been tested in service and found to be well adapted to industrial use.

Establish Objectives

In establishing an account subdivision system the following objectives are to be considered:

1. The account list for a cost estimate should present a logical picture of the scope of the project, with its major operating divisions identified and listed in operating sequence;
2. Individual account subdivisions should be identifiable as to type of construction work involved;
3. Account subdivisions should be work units which can be easily segregated and identified in the field;
4. The list of standard accounts should be complete enough to reduce the possibility of overlooking any major element of cost in the estimate;
5. The account system should be suitable for use with tabulating machines to reduce the cost of obtaining information on the larger projects;
6. The system should be as simple as possible, consistent with the great number of units to be classified and the many purposes which must be served.

It should also be noted that the account subdivision system must also satisfy requirements with respect to its use for property accounting, tax records, insurance premium computation, and construction planning.

The following account subdivision procedure is recommended:

A. The project's cost estimate and cost records should be broken down into primary divisions, each consisting of a major operating element of the project.

The titles of these primary divisions should, in general, state the purpose to be accomplished by the installations in that division. Where possible, the divisions should coincide with operating departments or subdepartments. They should be listed as nearly as possible in operating sequence. When distribution systems, collection systems, utilities, or buildings serve more than one division, they should be listed in separate divisions.

As a relatively simple example, an estimate for a 17,000 lb/hr boiler installation might have the following primary divisions:

−10 Fuel and Electrical Systems
−20 Boiler and Associated Equipment
−30 Steam, Condensate, Boiler Feed & Associated Piping

B. The work in each primary division should be broken down into construction account subdivisions in accordance with the work descriptions of a "Standard Account Subdivision List."

Each subdivision is assigned a four-digit number. The first two digits from the left are from a Standard Account Subdivision List, Table I. The first digit classifies the work as to general type of construction involved, that is: Structures, Piping, Electrical, and so forth.

The second digit further classifies, in a more detailed way, the type of construction work. For example, if the first digit is six and the second digit is one, the work involved is electrical lighting (61–). If the first digit is six and the second digit is three, then the work involved is some type of electrical power conversion (63–).

The third digit is the number of the primary division, and indicates the operating division of which this work is a part. It is separated by a dash from the second digit.

The fourth digit is a zero except when there is more than one item of a like classification in a primary division.

If more than ten items of like classification may occur in a primary division, the second group can be established with three digits instead of two.

The estimate for a 17,000 lb/hr boiler installation, previously cited, can be subdivided as shown in Table II.

Consider Dollar Value

Construction cost estimates based on records of former projects must be corrected to the current value of the dollar. This correction is usually substantial; general construction prices doubled in the thirteen years between 1932 and 1945, and doubled again in the eight years from 1945 to 1953.

Many indexes are available which purport to measure the change in value of the construction dollar. Some of the most widely used are:

1. Marshall & Stevens (Published quarterly in *Chemical Engineering*)
2. Nelson Refinery Index (Published monthly in *Oil and Gas Journal*)
3. Engineering News-Record Construction Index (Published monthly in *Engineering News-Record*)

Based on length of publication rec-

ord and promptness of availability, the ENR Construction Index is one of the best for general estimating use. It should be observed that, although the "Engineering News-Record" Construction Index measures in general the changes in value of the construction dollar, the prices of individual pieces of equipment, of buildings, of roads, of railroads, of pipe lines, and of other major items of construction will vary in a somewhat different manner. There are special indexes available to measure the fluctuations of many of these items.

These indexes can be used to good advantage on occasion. In general, the increase in accuracy obtained by using individual indexes for each item of a cost estimate is far outweighed by the resulting complexity. In cases where the greater part of the estimate is dominated by a single item, a large generator for example, the accuracy of the estimate can be improved by using the special index for such an item. In most such cases, however, a more accurate and almost equally prompt preliminary cost estimate can be obtained from a vendor.

For common types of equipment, information contained in cost records can be corrected to a standard cost index level and plotted on charts of capacity versus cost. This plotting speeds the selection of the past purchase most similar to the item required and permits graphical extrapolation. Log-log plotting of the data can be used. On this plotting paper, equipment cost data often shows straight line characteristics.

Since equipment capacity-cost data sometimes plots in a reasonably straight line on log-log paper, it can

Table. I. Standard Account Subdivision List. This list was prepared to meet estimating needs of one organization; it can and should be modified as required for needs of other groups. Consider changes well; once adopted further changes confuse

Preparatory
01 Land purchase
02 Land leases and rights of way
03 Clearing site
04 Site fill and excavation
05 Temporary process connections and enclosures
06 Repairing, relocating and re-conditioning existing structures and equipment. (Does not include modifications which increase capacity or efficiency.)
07 Project studies, owner's personnel
08 Project studies, associate engineers' personnel
09 ———

Structures
11 Subgrade improvements (piling, etc.)
12 Building foundations
13 Equipment foundations, concrete
14 Concrete grade slabs, pits, shafts, manholes, tunnels, and culverts
15 Building frames (with associated walkways and stairs)
16 Supporting frames, walkways and stairs (for tanks, equipment, piping, conduit and cables. Includes major supports only)
17 ———
18 Building enclosure (siding, roofing, floors, partitions, windows, and other architectural items)
19 ———

Storage (Including minor associated supports)
21 Gas and liquid storage, steel
22 Gas and liquid storage, nonferrous metal and nonferrous metal lined
23 Gas and liquid storage, nonmetallic, and nonmetallic lined
24 ———
25 Dry material storage, metallic
26 Dry material storage, nonmetallic
27 Ground storage (including dikes and dams)
28 ———
29 Insulation for storage facilities

Piping and Duct Work (Including minor associated supports)
31 Steel piping
32 Alloy steel piping
33 Cast and wrought iron piping
34 Nonferrous metal, and nonferrous metal-lined steel, piping
35 Nonmetallic, and nonmetallic lined, piping (including vitrified clay and concrete sewer piping)
36 Metal ducts and stacks for ventilation, gases and dust
37 Nonmetallic ducts and stacks for ventilation, gases and dust (including metal ducts and stacks with nonmetallic linings)
38 ———
39 Insulation for piping and ducts

Equipment (Driving equipment and minor associated supports included with each)
41 Space heating, ventilating and air conditioning equipment
42 Plumbing and sanitary fixtures
43 ———
44 Office, laboratory, personnel, and plant protection furnishings and equipment
45 Maintenance and repair equipment
46 Shipping containers and warehousing, shipping, packaging, and container manufacturing equipment
47 Wells (but not well pumps or exploratory drilling)
48 ———
49 Insulation for both service equipment and process equipment

Equipment (Driving equipment and minor associated supports included with each)
51 Evaporation, condensation, and isolated heat exchange
52 Electrolytic
53 Drying, burning and melting
54 Separation, filtering and screening
55 Reaction, adsorption, absorption, dissolving, and extraction
56 Size reduction, flaking, solidifying, densifying, crystallizing and mixing equipment
57 Dry and packaged material movement (including chutes and spouts)
58 Fluid movement equipment (including pumps, ejectors, compressors, blowers, and fans)
59 Instrumentation and control (with associated wiring and piping. Does not include instrumentation or control for electrical power)

Electrical
61 Lighting (including fixtures, conduit, wiring, switches, lighting transformers and lighting panels)
62 Power generation equipment
63 Power conversion equipment (includes transformers, rectifiers, and rotary converters)
64 Power control and metering equipment
65 ———
66 Power wiring and bus (including minor associated supports, insulators, conduit, and ducts)
67 ———
68 (Reserved)
69 ———

Site Improvements
71 Ditching, finish grading and planting
72 Roads, parking lots, area surfacing, and sidewalks
73 Railroads
74 Fence
75 Waterfront structures
76 ———
77 ———
78 Painting
79 Spare parts and equipment

Engineering Expense
Field
81 Field Engineering liaison
82 Survey — Layout
83 Survey — Property, Topographic and Hydrographic
84 Survey — Subsurface
85 Inspection
86 Testing
Design
87 Design Engineering (except studies) — owner's personnel
88 Design Engineering (except studies) — associate engineer's personnel
89 ———

Construction Expense
91 Procurement
92 Construction equipment, tools and supplies
93 Temporary facilities
94 Services
95 Administration and Fees

Table II. Account subdivisions for estimating installation of boiler

Account	Description
–10	**Fuel & Electrical Systems**
31–10	Gas Piping — up to control valve
61–10	Lighting — boiler area
64–10	Power control wiring
78–10	Painting
–20	**Boiler & Associated Equipment**
03–20	Clearing site
13–20	Equipment foundations
14–20	Pipe trench
36–20	Boiler stack
49–20	Boiler insulation
51–20	Boiler, burner & accessories
58–20	Boiler feed pump
59–20	Boiler instrumentation
66–20	Power wiring
78–20	Painting
–30	**Steam, Condensate, Boiler Feed & Associated Piping**
06–30	Relocate process water line
16–30	Pipe supports
31–30	Steel piping
39–30	Piping insulation
78–30	Painting
–90	**Design & Field Expense**
87–90	Company Engineering
88–90	Associate Engineering
90–90	Construction expense

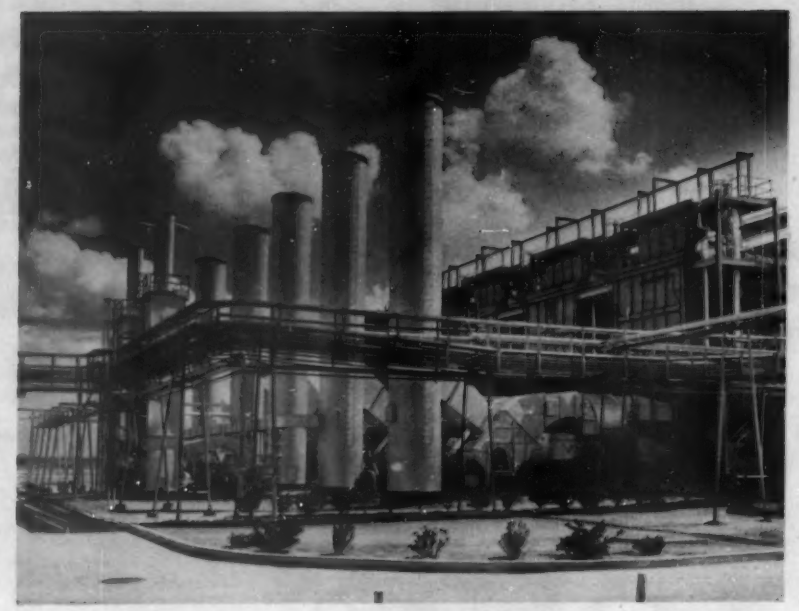


Fig. 3. Outdoor boiler plant at Houston. Costs for this type of plant differ widely from those for monumental types — an important factor in quick estimates

be assumed that equipment cost may be related to capacity in the exponential form:

$$\frac{\text{Cost of A}}{\text{Cost of B}} = \left(\frac{\text{Capacity of A}}{\text{Capacity of B}}\right)^x$$

where x is the Capacity-Cost exponent, and is usually less than one.

Equipment cost data has been analyzed, and capacity-cost exponents determined, for a wide variety of industrial equipment. W. L. Nelson presented a long list of such exponents in his "Costimating", *Oil and Gas Journal*, Oct. 5, 1950, page 263. They vary from 0.35 to 1.06, with usual values in the neighborhood of 0.6.

It should be pointed out that this exponential relationship between capacity and cost is more clear-cut and reliable for the purchase price of individual pieces of equipment than it is for the cost of installed equipment or complete plant units. An example will show the use of the capacity-cost exponent, as follows:

Required: December 1954 purchase price of a boiler with 17,000 lb/hr capacity.

Known: Purchase Order price, October, 1952, 5200 lb/hr capacity boiler; $9100, F.O.B. factory.

ENR Construction Cost Index for December 1954 = 640

ENR Construction Cost Index for October 1952 = 588

Cost of 5200 lb/hr boiler in December 1954

$$\frac{640}{588} \times \$9100 = \$9900$$

$$\text{Capacity Ratio} = \frac{17{,}000}{5200} = 3.27$$

Capacity-Cost Exponent = 0.6

$$\text{Cost Ratio} = (3.27)^{0.6} = 2.04$$

Estimated purchase price, 17,000 lb/hr boiler, 2.04 × $9900 = $20,200, F.O.B. factory.

Select Methods in Advance

By establishing a series of estimating methods for use on projects of varying degrees of definition, we can be prepared in advance for most of the estimating situations which may arise. We need quick approximate methods for some situations and more detailed methods for others.

Each of these methods should be supplemented by a form, or a series of forms, which will jog the estimator's memory so that he includes all of the variables significant to the type of estimate he is making. These forms are far from being "red tape." Their greatest value develops on rush jobs where the pressure to complete the estimate makes it difficult to recall everything which must be included. Actually, if a form is designed to provide the best and quickest estimate in an emergency, it will probably also be the most efficient way to do day-by-day estimating.

Although there is not enough space to present the detail of the methods, there is a series of five which are available, as follows:

1. Detailed Estimate Method: made by pricing in detail a complete material and labor take-off from fully detailed drawings. Produces accurate estimates but is quite costly in time and money.

2. Preliminary-Bill Method: made by pricing all equipment and other material from preliminary lists; pricing labor by ratio to these equipment and material costs, using average expected labor rates, and taking into account expected job conditions. This type of estimate and estimate form is shown for a relatively simple project in Fig. 2a. It is less accurate than a detailed estimate, but can be prepared in about a fourth of the time from much less detailed drawings.

3. Layout Method: made by detailed pricing of equipment only, approximating the material required to install the equipment by ratios typical of the equipment involved. Material for buildings, distribution systems, and yard improvements is estimated from a preliminary general layout on a unit price basis (dollars per sq ft of building, dollars per ft of track, etc.). Labor is estimated by corrected labor-material ratios and average labor rates, as for a Pre-

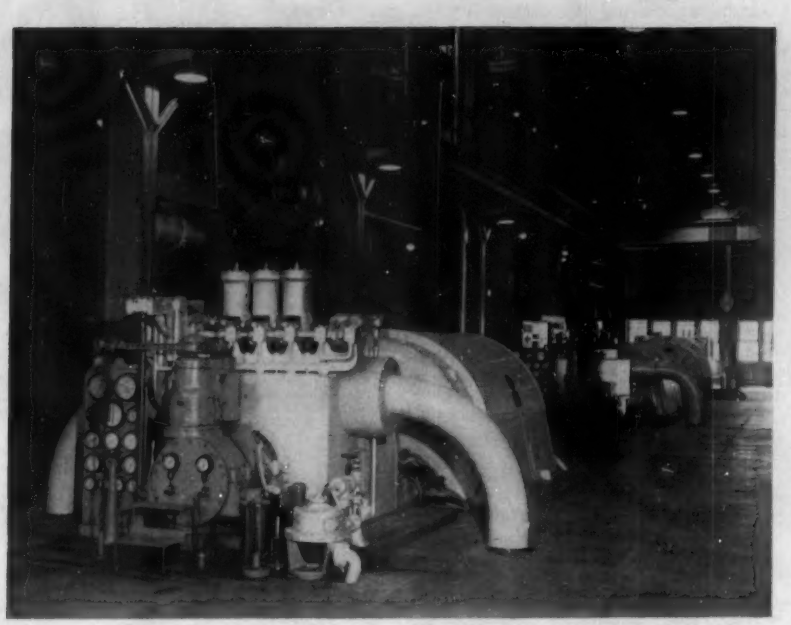


Fig. 4. "Generator Alley" in powerhouse of Diamond Alkali's Painesville Works. For this type of construction, detailed plans are the estimator's best friend

liminary-Bill estimate. This method is still less accurate, but can be made quickly from much less nearly complete design information.

4. Equipment Ratio Method: major process equipment only is priced; with auxiliary equipment, installation material, buildings, distribution systems and so forth estimated by means of ratios typical of the major process equipment installed. Labor is estimated by corrected ratio to material, and average labor rates, as before. This method is rapid and produces estimates of reasonable accuracy for preliminary studies. It is necessary to select, size, and price the major equipment with some care, but no other engineering design work is required. The method and estimating form are shown in Fig. 2b.

5. Capacity-Cost Method: knowing the capacity and cost of an existing plant, the cost of a new one of different capacity can be assumed to be in proportion to the ratio of the capacities of the two plants to an exponential power, usually on the order of about 0.7. This is the simplest, but one of the most deceptive methods available.* It is usually advisable to take a little more time and prepare an estimate by one of the previously listed methods which will take into account at least the major features of difference between the proposed unit and the existing one.

Estimates are usually needed in a hurry. There is a bid opening date to be met, or an appropriation request to be prepared for a forthcoming board meeting.

All of the information and ratios required for an estimate by one of the previously mentioned estimating methods can, of course, be computed and compiled at the time of estimate. This has the advantage that only the information required for the particular problem at hand is selected and computed.

Tailor-Made Data Help

On the other hand, the precomputation and tabulation of such data has much in its favor, especially if there is a fairly continuous volume of estimating work to be done. Estimates can be completed in a half to a third of the time required when using "tailor-made" data. Often too, the tabulated data from all available projects reveals relationships and trends which make accurate extrapolation possible. There is also less chance of overlooking valuable data from some past project with which the estimator is not personally familiar. Finally, the pre-computation of estimating data can, with suitable supervision, be accomplished by clerical personnel, conserving the estimating engineer's time for actual estimate production.

Actual experience, when recorded in the form of an "over-run diagram" like Fig. 1, will indicate that every estimate needs an allowance for contingencies, and that this allowance should be greater for estimates made before the definition of a project has been firmly established. However, if we were to establish an allowance for contingencies adequate to cope with all of the mischances which plagued our most unfortunate past project, then for the vast majority of the projects built, our estimates would be much too high; and high estimates produce loss of efficiency and the other evils previously mentioned.

It is therefore proposed that we add to our "bare" estimates an allowance for contingencies which will be adequate in, say, one out of every ten cases. This allowance must necessarily be greater for the more poorly-defined projects. It can be represented by a rising line, such as the one marked "0.06U" on the "over-run diagram" of Fig. 1, with one-tenth of the plotted points lying below the line. An estimate made up of the "bare" estimate plus this minimum allowance for contingencies provides an excellent "target" estimate

* See W. L. Nelson's comments in "What Price Complete Refinery Installations," *Oil & Gas Journal*, November 23, 1953.

for the design and construction period. It is realistic in that it takes into account the fact that there will always be "unlisted items" which are unknown or overlooked when an estimate is made. On the other hand, the allowance is slender enough to encourage the designers and the construction force to meet or beat the estimate and put the project in the "superior" classification.

On the other hand, we must face the facts of life as indicated by the over-run diagram. Not all of the projects will be "superior." Some will be mediocre, some will be poor, and some will be "dogs." We need a method of advising management as to the possibilities with respect to over-runs if the project meets with some of the misfortunes which have hit previous projects.

Use of Restricted Reserve

For this purpose we can establish a "restricted reserve", indicating the additional money which may be required for the project if almost everything goes wrong. The amount of this reserve must, as indicated by the over-run diagram, be greater for projects of poor definition. It can be established, as shown in Fig. 1 by the line "0.18U", so that nine projects out of ten can be completed within the total of the target estimate and the established restricted reserve.

The possibility that all of the restricted reserve must be used up to complete the project is one of the factors to be considered by management in appraising its desirability. This possibility should also be considered in planning for the financing and execution of the project.

Sometimes the size of the restricted reserve will be appallingly large. Toward the right of the diagram the restricted reserve is almost as great as the target estimate. Under these conditions it is apparent that the estimate is very rough indeed. Quite often the decision will be made to improve the definition of the project by taking foundation borings, making layouts, diagramming the utility system, or even making detailed drawings, before giving the project final authorization. The increase in project definition resulting from this design work will materially decrease the project's unknowns and correspondingly decrease the required restricted reserve.

At any stage in a project's development when an estimate is to be made, the size of the restricted reserve, being expressed in dollars, is an easily understood measure of the accuracy of the estimate. In this respect it is better than the easily-overlooked and frequently misunderstood labels of "preliminary" estimate, "construction" estimate, "rough" estimate or "horse-back" estimate.

We hope that these comments on estimating "Whys and Hows" will help to provide the estimator with a rounded picture of the available estimating methods and procedures that can be used.

Some of the methods presented are from established practice, some are modifications of methods proposed by others and some are new. Much of the presentation has been necessarily of a sketchy nature. This is probably as it should be, since estimating methods and especially their details of application must be varied to fit the particular needs of an organization.

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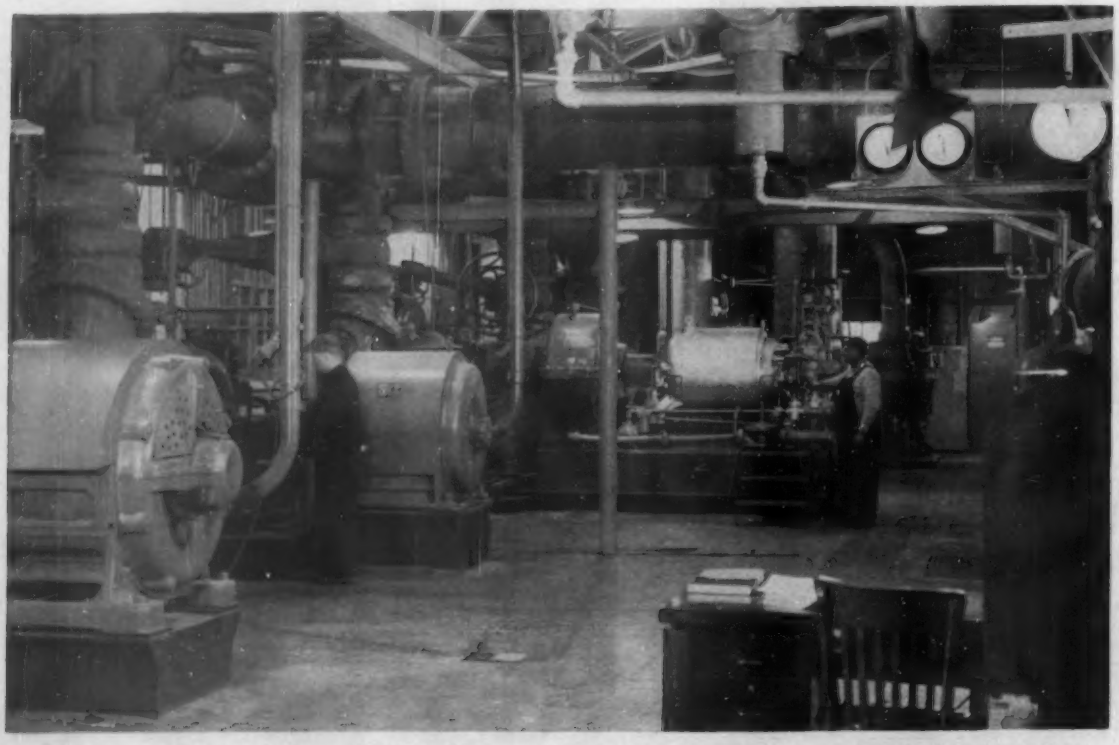


Fig. 5. View of pump room at Painesville, Ohio, Works of the Diamond Alkali Co. shows complexities faced by estimator

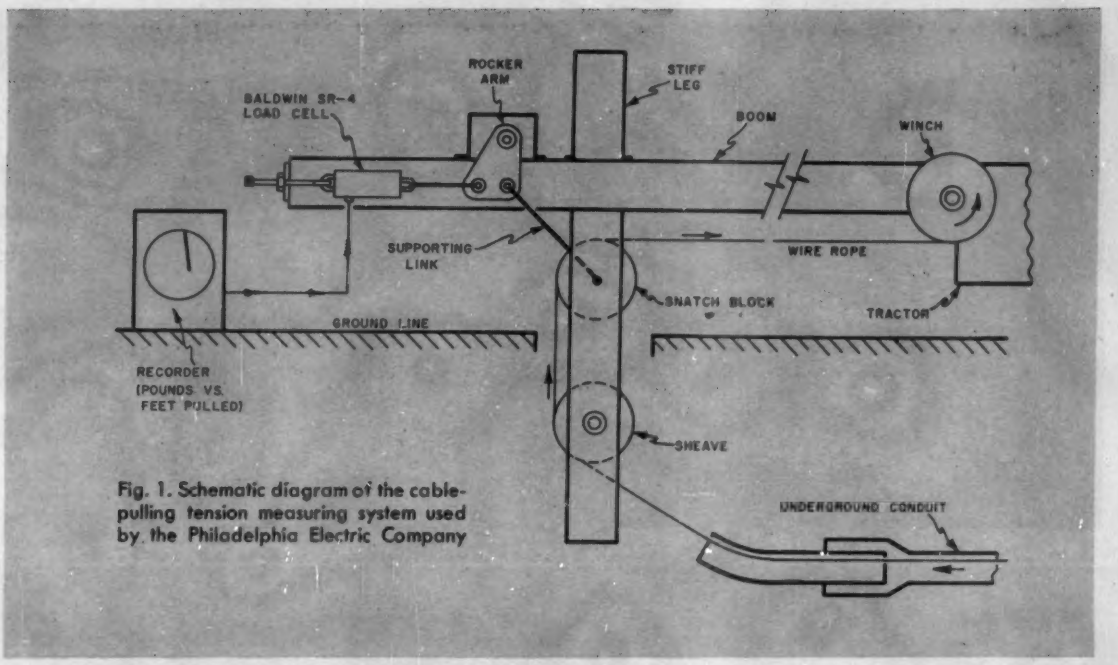


Fig. 1. Schematic diagram of the cable-pulling tension measuring system used by the Philadelphia Electric Company

New Device Measures and Records Cable Pull

FORCES REQUIRED to pull electrical cables through underground conduit are being measured by a newly developed electrical method which provides a continuous record of pulling forces.

In a cable-pulling system developed by Philadelphia Electric Company, the winch drum on the cable-pulling tractor pulls wire rope over a snatch block which is supported by a link to a vertically suspended rocker arm attached to the boom. Horizontal movement of the arm is restrained by a Baldwin SR-4 load cell which is an electrical force transducer for transmitting load signals to a recording instrument. The wire rope runs from the snatch block vertically down through a manhole opening, over a sheave on the vertical stiff leg that is mounted on the boom, and into the conduit to the lead end of the electrical cable by way of a deflector tube. This arrangement is shown in Figs. 1 and 2.

A maximum pulling force of about 20,000 lb was observed for a maximum length of 3300 ft of cable by Philadelphia Electric Company. Pulling speeds were normally between 20 and 35 ft per minute, as determined by timing recorded lengths being pulled. The charts obtained through this application resistance wire strain gages provide a graphic record of instantaneous loads, making possible a better evaluation of the factors contributing to pulling tensions.

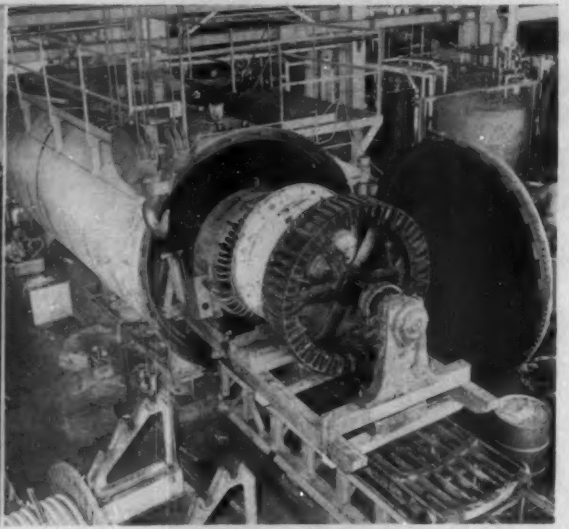
In a cable-pulling system developed by Duquesne Light Company, Pittsburgh, and used for the first time recently, two Baldwin SR-4 load cells of 50,000 lb capacity each support most of the cable-pulling equipment and trailer truck on which it is mounted, as well as all of the tensional force in the vertical portion of the pulling line. The cells are aligned with and equidistant from the vertical portion of the pulling line which runs through the manhole under the truck. Use of the tension measuring and recording equipment required only the addition of two steel plates on the truck frame thus making the cells readily adaptable to support more than one rig. The arrangement of the Duquesne Company's equipment is illustrated in Fig. 3.

While pulling 1756 feet of 3-conductor cable weighing 18.75 lb per ft through 8 1/16 in. I.D. pipe the recorded pulling force reached a maximum that compared favorably with the calculated maximum of 12,165 pounds.

Industry-wide use of devices of these types may be expected to clarify the effects of such variables as the coefficient of friction, type of lubricant, pulling speed, and others, eventually making it possible to determine the extent to which tensions may be controlled and reduced.

Fig. 2. Cable tension is measured by load cell at end of boom and recorded by instrument shown in foreground

Fig. 3. Duquesne Light Co.'s system in which cable pull is measured by load cell on which equipment rests



(Above) Flood-damaged motor in North Connecticut gets a bath and drying out at GE's Wire and Cable plant, Bridgeport. Steam and solvent cut out mud, oil and slime, then the whole rotor is trundled into the vulcanizing ovens (at right) for its double-quick drying out. These ovens are normally used in cable manufacture.

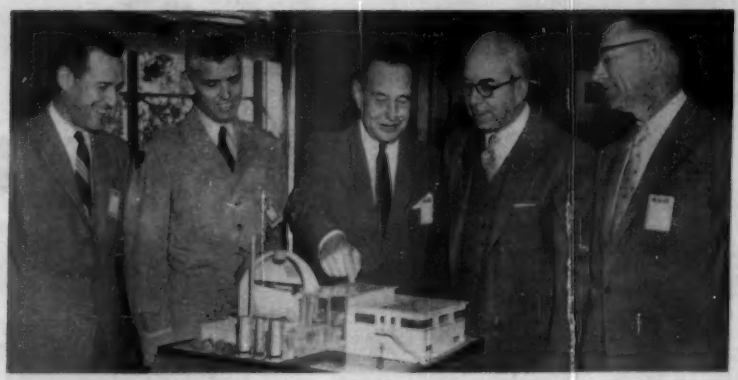
News Reel

First of six 345-kv autotransformers destined for line between Umatilla, Ore., Ampere, Wash., gets test okay at A-C

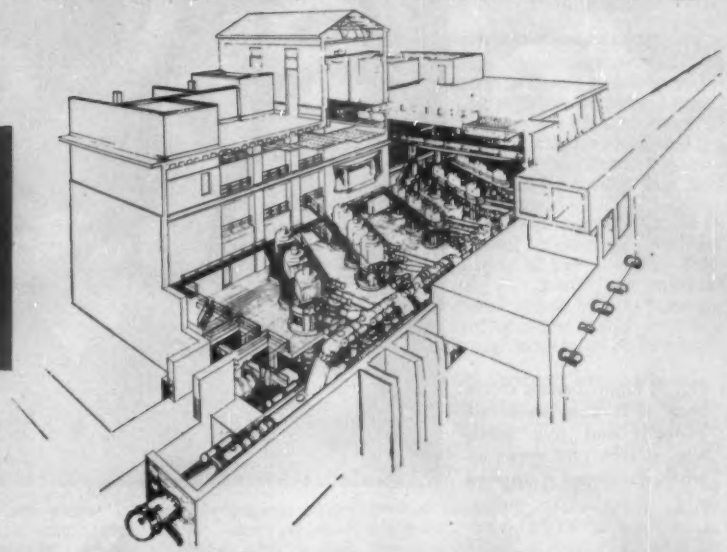
Rated at 400,000 kva, this Westinghouse autotransformer is the first close-ratio unit of this type applied to 330-kv

(Above) Modern coal-unloading tower by Mead-Morrison features service elevator, dust suppressors, for Astoria Station of Consolidated Edison Company

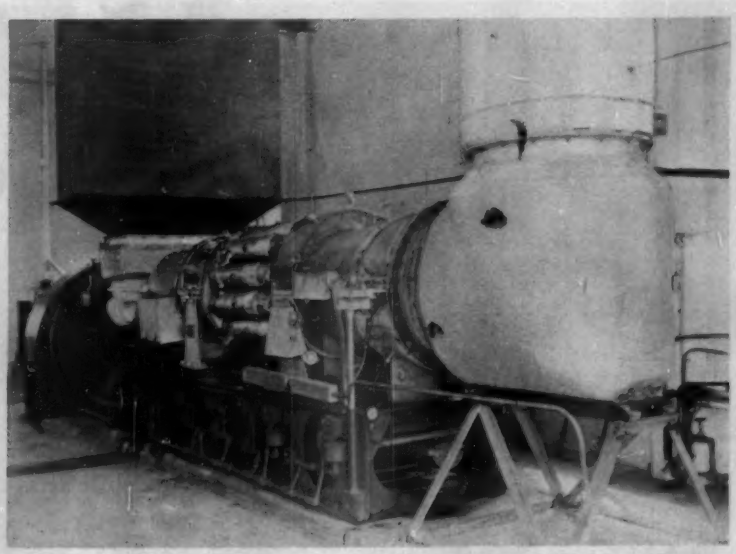
(Right) Washington, D. C., is getting 15 new vertical-shaft Worthington water pumps with a total capacity of 477 mgd



AEC's Strauss is presented a model of Army Package Power Reactor. Left-to-right: ALCO's Kasschau; Army's Col. Lampert; Admiral Strauss; and ALCO's Adm. Leggett



To generate heat—not havoc: These B&W atomic fuel elements were shown off to AEC's Dr. Libby by B&W's president, Alfred Iddles (left), at the Atomic Trade Fair, Geneva, Switzerland



Larned, Kansas, becomes first city to own gas turbine with this 1250-kw Westinghouse simple cycle unit. Data: air 53 psig; gas 1250 F/780; rpm is 8750/1200

Armco Avoids Accidents With

Fig. 1. Right. Testing crane hook with dye penetrant method. Red dye seeps into a crack and shows up when developer is applied

Fig. 2. Above. Crack in chisel detected by magnetic particle test. Particles of magnetic powder concentrate in crack

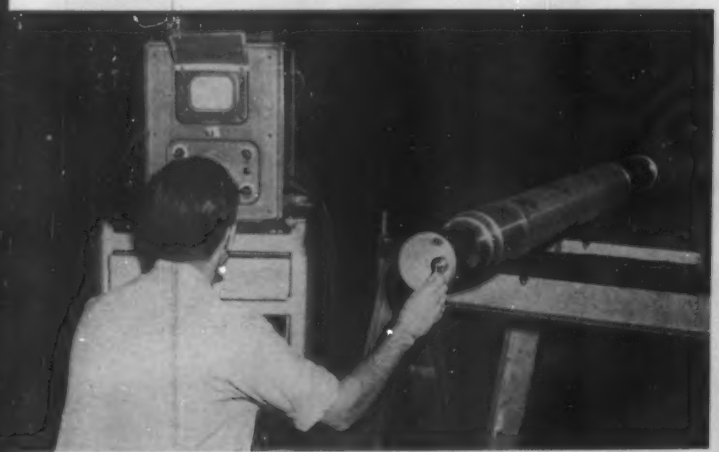


Fig. 3. Above. Supersonic testing to detect internal flaws. Sound waves are reflected from flaw and their time is measured as in radar

Fig. 4. Right. Using stencils or tags, inspector marks each chain that's been tested and approved. Information is then recorded in a log book

Lifting Inspection Program

Regular inspection and tests of chains, hooks, pins, hand tools and other equipment have reduced accidents and lowered inventories. Here is an outline of the system with a description of each test

By N. C. PATTERSON*

FOR THE PAST YEAR and a half we have been operating a very effective program for selecting and inspecting lifting equipment. A survey which led to this program being put into effect showed that we carried a wide assortment with overlapping equipment and many spares. The departments involved were asked the reason for such variation and excessive inventories. Nearly always the answer was slow delivery on alloy chains and high maintenance on regular chains.

A program was set up to inspect this equipment and to replace regular chains with alloys. A system of purchasing and distribution was set up. As each department returns a regular chain for repairs, a new alloy chain is issued, and that department pays for the new chain. Alloy chains already in use are turned in for repairs; a repaired alloy chain is issued and the chain is sent to the manufacturer for repair. The department pays for the repairs on the returned chain, and this chain is held as a spare for any other department requiring that size chain.

Inspection Program

A program for chain inspection was then set up. One man was appointed, under Forge Shop supervision, as a Chain Inspector. He is a graduate apprentice blacksmith, familiar with chain repairs, and he was given the necessary training in electricity and simple metallurgy to enable him to carry out the testing program. He attends classes sponsored by a testing company and acts in an advisory capacity as a safety and mechanical engineer. As each department is inspected, the chain inspector is helped by the department inspector or other qualified personnel.

At present inspections are semi-annual, and in many sections more often if required.

The general procedure is for the foreman to notify the department, twenty-four hours in advance, and an inspection is to be made. A check is made on general operating conditions, in order not to conflict with mill operations. Upon entering a department, the inspector notifies the supervisor and receives help for inspection, and discusses conditions of the equipment with the operating personnel. The chain inspector is at liberty to make spot checks and select his own starting points. In addition, the foreman makes visual inspection of equipment of any department at random intervals. If a piece of equipment is found to be unsafe, it is removed from service by tagging it out with a special red card, on which the defects are noted. The Shops, Production and Maintenance Department Foremen are notified immediately, and steps are taken for repair or suitable replacements.

A complete set of records is maintained to assist departments and inspectors. Each piece of equipment has a record or history sheet and a number and department card for each piece inspected. This sheet covers a diagram or a complete description, along with the date it was placed in service, the material used, handling capacity and other pertinent data. Each inspection is recorded, covering the conditions found and recommendations made, if any. After a department has been inspected, a report is made and duplicates sent to the department handling maintenance, the foreman, Maintenance Superintendent, Safety Department and a file copy is kept. A follow up is made to determine whether or not recommended changes or repairs have been made.

There are, at present, four types of non-destructive tests made.

Magnetic Particle Test

Magnetic particle test is a means of detecting flaws at or near the surface of ferro-magnetic materials. The material to be tested is first magnetized, then sprinkled with a finely dissolved powder. The powder, being magnetic, tends to concentrate wherever a flaw interrupts the charge. This method works on the principle that carbon steels have a permeability one thousand or more times greater than air. Any break in the material sets up resistance to the magnetic lines of force. Magnetic lines jump from one side of the interruption to the other, setting a new magnetic pole. This acts upon the iron powder and forms concentration at the break and results in the indication of the flaw.

The equipment used is a transformer producing low voltage, high amperage, alternating current from 3 to 3000 amperes at short intervals of 1 to 5 seconds.

The magnetic particle method is applied to show fatigue, forge, thermal, weld and grinding cracks.

Ultrasonic Inspection

Ultrasonic inspection is used on other material as well as ferric materials. Impulses are sent into the material by means of piezo-electric crystal units, and the time is measured for the vibrations to penetrate the material to the end or to the flaw and return to the crystal.

A pattern is formed on an oscilloscope screen, indicating position and magnitude of the break or flaw. Application is made on railroad wheels, diesel axles billets prior to forging, and to other heavy material where internal flaws must be detected.

Dye Penetrant Inspection

Dye penetrant inspection is applied on surfaces of all types of materials where only surface flaws are to be found. The principle of this test is the ability of a low tension liquid to seep or dissolve into a crack. After allowing from 5 to 30 minutes to soak, the excess liquid is cleaned away with a cleaner and dried. A developing liquid is painted or sprayed over the area and allowed to dry. In drying, the developer acts as a blotter and draws out the penetrant. Since the penetrant is colored red, and the developer dries white, a definite indication of any crack or defect is formed. This application is made on certain handling equipment, tractor prongs, the base of tractor tongs, crane hooks, break-down bars, etc.

Visual Method

The visual method is set up to permit the operator to apply gauges, calipers and standard data supplies by various manufacturers. Hooks are marked at the shank and point with a permanent mark. Each time it is inspected, the measurement between the points is recorded and any deviation from the original measurement indicates an opening or damage to the hook. Wear allowance on rings, hook eyes, links and chain stretch not exceed more than 10 per cent at any one point.

*Assistant Foreman, Machine, Forge and Locomotive Shops, Armco Steel Corporation, Butler, Pa.

Each piece of equipment has its own procedure for inspection. For instance:

Chain Slings: Magnetic particle on main and connecting links. Visual inspection for each link and all over length measurement to check for stretch.

Crane Hooks: Dye penetrant inspection and visual point check for opening. Wear at throat and neck of hooks.

Coil Hooks and Tongs: (1) Forge: Magnetic and visual inspection at mouth of opening. Links, bolts, dye penetrant inspection of connecting links, magnetic or dye inspection. (2) Fabricated: Hooks or tongs. Visual inspection of hook points, dye penetrant at welded surfaces, magnetic inspection on plates. Connecting links and pins visual and dye check inspection.

Tongs: Bolt and dye by visual inspection. Grippers and joints and any bends by dye penetrant inspection.

Tractor Tongs: By magnetic particle inspection on main tong links. Base and cracked links Chain and ring hooks by visual inspection.

Ladle Trunions: Dye penetrant method and on a monthly basis.

Hand tools such as gauges, chisels, cold cutters and break down bars have a system set up to eliminate possible spawls and other damage caused by overload. Each piece is magnetic particle tested prior to issue and re-dressing. Each six months the tools are recalled and new ones issued. This is accomplished by marking the identification on each piece of equipment with a red colored dot for tools issued January through July. A yellow dot indicates those issued July through December. This system keeps tools from accumulating in boxes and helps to keep all tools in good condition.

At all times operators are required to bring in faulty tools and receive new ones, without any questions asked. No tools are given out without an old tool, of the same type, being turned in, or without a requisition from the foreman. All tools to be redressed are cleaned and inspected prior to repair and inspected and checked after repair, and then they are stocked for distribution. In addition to chain and tool inspection, maintenance equipment is inspected for cracks or flaws such as ladle crane load brake discs, armature shafts, miscellaneous shafts, levers, bearing races, housings and drives.

Cable Inspection: Except in a few cases, cable inspection is based on hours of operation or time, whichever comes first. Inspection of crane cables comes under the crane inspection program. As yet, a cable inspection method has not been developed to any extent, for general inspection. A method is under development, but has not proven to be 100 per cent effective.

Coal Flows Like Water

A METHOD of emptying fine coal from a bunker almost as fast and completely as water runs from a tank is being tested at the Bituminous Coal Research General Research Program, Columbus, Ohio, laboratory in a project jointly sponsored by the General Research Program and the BCR Locomotive Development Committee.

When fine dry powders as flour, cement, catalysts, etc., are "fluidized" by passing air through them at low velocity, they can be made to flow through pipes or along troughs under the influence of either static pressure or gravity. The purpose of the LDC-BCR project is to apply the same technique to relatively coarse crushed coal with top sizes up to ⅜-in. Prior to the present study, it was thought that the upper particle size limits for such fluid-like behavior was about 100 mesh. Some preliminary work done at LDC's Dunkirk laboratory indicated that aeration could give these properties to much coarser material.

The primary objective of the present investigation is to determine the upper size coal that can be made flowable by aeration. The flow characteristics of crushed coal being discharged from flat-bottomed tanks were investigated by studying the influence of size consist, moisture content, and coal origin, for varying degrees of aeration. The Locomotive Development Committee would apply this method to the discharge of coal from the bunker of a coal-fired gas turbine locomotive.

The tests described here are giving promising results. The photograph shows an experimental hopper

Experimental hopper from which coal is being discharged by aeration process

from which coal is being discharged by aeration. The bottom of the hopper is porous; air is forced through this porous bottom at low velocity. At certain air velocities, which are governed by coal size and surface moisture, the coal becomes aerated.

In this condition the flow characteristics of the coal change from those of a bulk solid and the coal flows like liquid. Almost all the coal is cleared from the tank except for a small amount lying at a low angle of repose along the bottom. The photograph shows the almost flat surface of the coal in the tank. The tank was full before the picture was taken.

A great advantage of the aeration process is the fact that it permits a fuel storage tank to be filled to the top, without the usual cone which extends from the chute into the tank. By aerating the tank while it is being filled, the surface of the crushed coal rises like a liquid and remains horizontal until the tank is full. Virtually the entire volume of a tank can be used for storing coal, and all of the coal can be discharged when it is needed except for the relatively small amount which remains because the final angle of repose of the coal does not come down to zero.

The results of this investigation indicate that the aeration method has promise for application to industrial and utility plants using small-size coal, as well as for locomotive application.

"I'm — ahh — in public utilities . . ."

So—You're Going to Overhaul Your Turbine Generator!

This is the eighth article in a series describing the scheduled overhaul of a 25,000 kw turbine generator at U. S. Steel Corp.'s South Works in Chicago. A list of past and future articles is given below. When all the articles have been published we plan to reprint the whole series. To reserve a copy of the reprint write to the Editor

VIII. CHECKING CLEARANCES

Clearances were carefully checked before reassembly to make sure spindle was properly located with respect to the cylinder, with correct operating clearance between the rotating and the stationary turbine parts

Checking clearances at each side of the spindle. Top and bottom clearances were measured by method of leading

I. Preview of whole series. II. Planning . . . Preparation . . . Preliminary work. III. Removing turbine cover and spindle. IV. Turning turbine cover. V. Reblading. VI. Metallizing eroded shaft. VII. Machining turbine spindle. VIII. Checking clearances. IX. Work on generator. X. Re-aligning turbine spindle. XI. Balancing. XII. Miscellaneous work. XIII. Safety and time-saving ideas

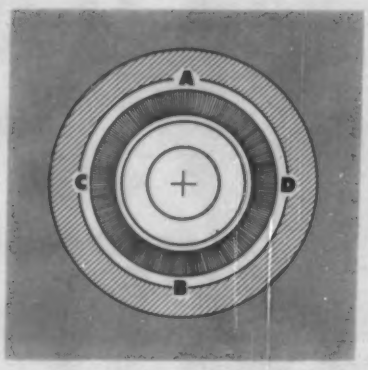


Fig. 1. Diagram of spindle and cylinder. Clearances were measured at points marked A, B, C, D

Fig. 2. Checking clearance between blading and spindle with feeler gage

Fig. 3. Checking gap between dummy piston and cylinder with feeler gage

BLADE CLEARANCES were carefully checked after machining. The purpose of taking the clearances was twofold. First, to establish that operating clearance between rotating and stationary parts was adequate and as specified. Second, to make sure spindle would be properly located with respect to the cylinder.

In practice these clearances were checked at points A, B, C and D (Fig. 1). The shrouding had been trimmed with the spindle rotating in its bearings, making the shrouds concentric with the spindle. Measurements of the shroud clearances could then be used to set the spindle with respect to the cylinder.

The clearances at C and D were easily measured with a feeler gage, as shown in Figs. 2 and 3. In Fig. 2 the clearance is being measured between the fixed blading and the spindle body, while in Fig. 3 the gap between balance piston and casing is being checked. In Fig. 4 the alignment of blade shrouding with the blade foundation is being checked by means of a straight edge and feeler gage. These three illustrations also show some of the precautions taken to keep dirt and metal particles out of the inlet ports and extraction openings in the turbine casing. In addition to burlap in the larger openings, Fig. 2 shows effective use of rubber hose.

The clearances at A and B (Fig. 1) obviously could not be checked with feeler gages, and so the lead wire method was employed. The principle is the same as that used in the well-known method of checking bearing clearances, illustrated in Fig. 5, where strips of soft lead are shown being laid on the shaft. When the bearing cover is tightened it compresses the lead, and when the cover is removed the thickness of the lead gives the clearance between bearing and shaft.

To measure the clearance at A and B in Fig. 1, lead strips were laid on the bottom of the turbine casing as shown in Fig. 6 and also on the fixed blade shrouding. Then the spindle was placed in its bearings, and more lead strips were placed on the spindle body, as in Fig. 7, and on the shrouding, as in Figs. 8 and 9.

Then the turbine cover was put on and tightened down, compressing the lead strips an amount depending on the clearance at each point. Cover and spindle were then removed and each lead strip measured to determine the clearance for each row of blading.

As diagram in Fig. 10 shows, the blade shrouding made sharp dents in the lead strips, and clearances were measured with the dial indicator and anvil shown in Figs. 11 and 12.

When all the clearances had been measured the results were plotted on a diagram. The diagram showed that slight horizontal and vertical adjustments of the spindle were required. Necessary adjustments were then made to relocate the spindle so reassembly could proceed. These adjustments will be described later.

Fig. 4. Above. Checking alignment of blade shrouding with blade foundation using a straight edge and feeler gage

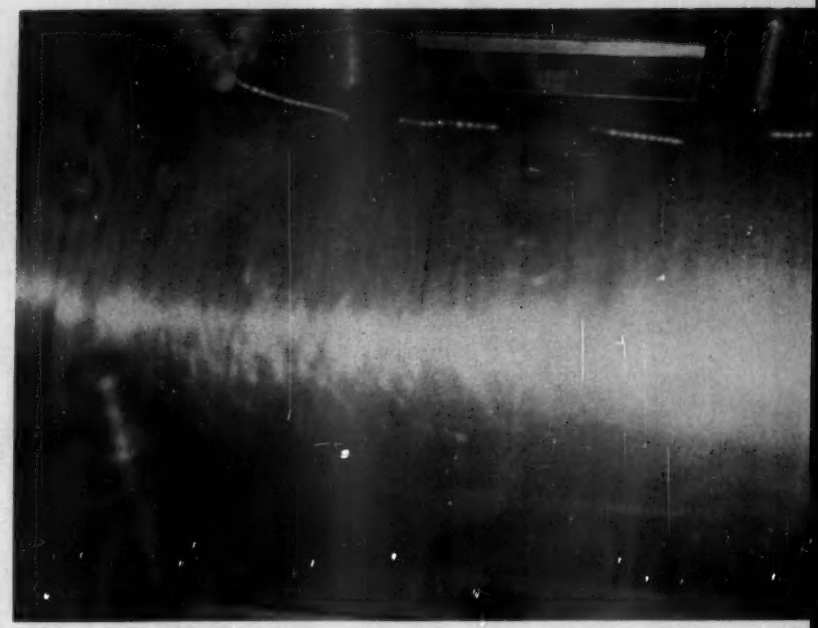


Fig. 5. Right. Lead strips being laid on shaft for bearing clearance check. Similar method is used to check top and bottom clearances of turbine blading

Fig. 6. Below. Strips of lead in position at lowest point of turbine casing and also on shrouding of fixed blading

Fig. 7. Left. When all lead strips had been positioned as shown in Fig. 6, the spindle was replaced and more leads were laid between blade rows

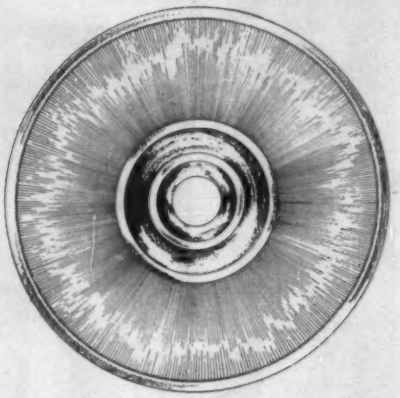
Fig. 8. Below left. Lead strips were then laid on each row of blade shrouding

Fig. 9. Below right. Another view showing how lead strips were placed where clearance measurements were required

When all these articles have been published the series will be reprinted. Here are some ways the reprints can be used:

1. To train young engineers.
2. To brief new men before an overhaul.
3. To show management why overhauls need so much time.
4. To illustrate parts when discussing any turbine problem.

If you want one or more reprints write to the Editor.



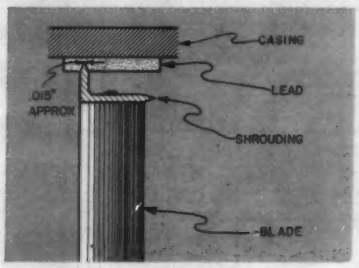


Fig. 10. Left. Diagram showing how shrouding dents lead strip. Thickness of strip below dent gives clearance between shrouding and casing

Figs. 11 and 12. Below. Using dial micrometer and anvil to measure thickness of lead strip below indentations

NOW IT'S Automatic Demineralizing

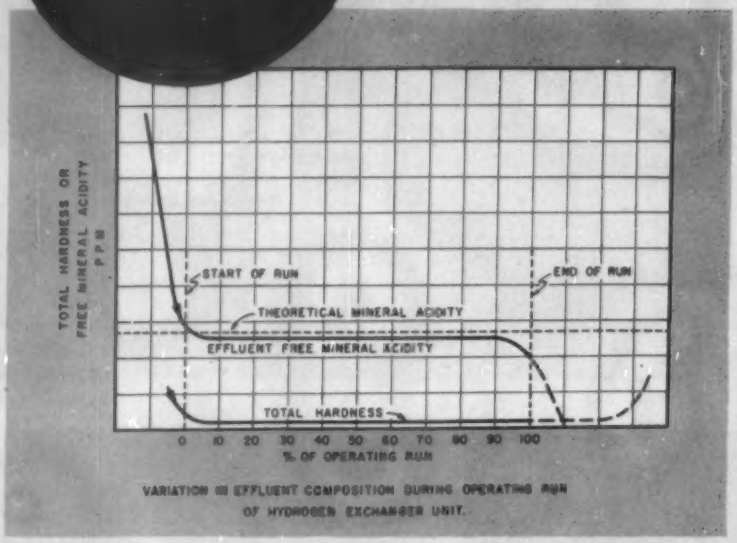

TOTAL HARDNESS OR FREE MINERAL ACIDITY P P M
START OF RUN
END OF RUN
THEORETICAL MINERAL ACIDITY
EFFLUENT FREE MINERAL ACIDITY
TOTAL HARDNESS
0 10 20 30 40 50 60 70 80 90 100
% OF OPERATING RUN
VARIATION IN EFFLUENT COMPOSITION DURING OPERATING RUN OF HYDROGEN EXCHANGER UNIT.

Fig. 1. Variation in the effluent composition during the operating run of a typical hydrogen cation exchanger. Note sharp FMA drop starting at 90 per cent run

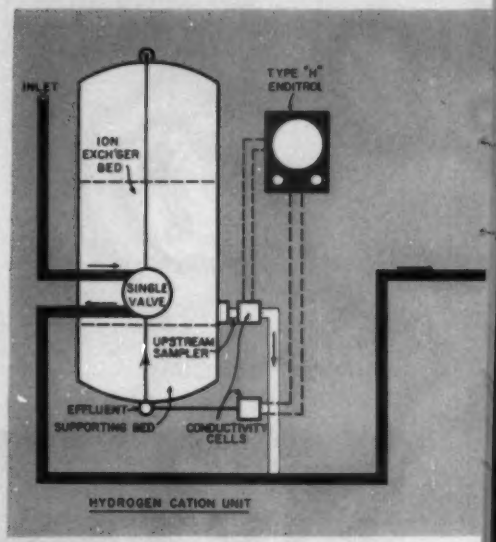


Fig. 2. Schematic flow diagram of a two-step demineralizer utilizing Enditrol

By **ROBERT H. MARKS** *

PUSH BUTTON automatic and fully automatic operation of demineralizing equipment is finding increased favor among power plant engineers. Automatic control insures correct exchanger regeneration and uniform demineralized water quality in addition to reducing the amount of labor to run the plant.

Demineralizing takes place automatically as long as the resins are in the regenerated form. When the the useful exchange capacity is exhausted, regeneration is required before additional demineralized water can be produced. Determining the end of the operating run of an exchanger is therefore very important. Once this is done, the regenerating process can be carried through to completion by any one of several automatic sequence control systems. In the past, there has not been available a satisfactory control device to automatically indicate the end of the operating run on a hydrogen cation exchanger, a highly basic anion exchanger, or a mixed bed ion exchanger.

Water meters have been most frequently used for terminating exchanger runs after a fixed pre-set volume has passed through the meter. For example, the meter on a cation unit is set to correspond to the rated exchanger capacity based on the influent water analysis. Chemical analyses of the free mineral acidity (FMA) of the effluent at the end of the run provide a check on unit performance. In the case of the highly basic anion exchanger and mixed bed demineralizer, the water meter is set to correspond to a predetermined silica endpoint. This is obtained by making a series of chemical analyses for soluble silica during the latter part of the operating run.

Meter control by fixed volume is used on thousands of operating exchangers but has several serious drawbacks. First, the factor of safety used in the meter setting to prevent over-running increases regenerant chemical consumption and water wastage. Second, with raw water of varying composition many meter re-settings are necessary to compensate for these changes which often take place quite rapidly and greatly increase the opportunity for under-run or over-run of an exchanger. Over-run effect is cumulative and may eventually lead to a noticeable drop in exchanger capacity in addition to producing water of inferior quality. Third, meter control increases the labor needed to run the plant since close attention is required to insure satisfactory control.

Endpoint indication and control through continuous recording pH meters has proved unreliable in most instances because the changes in pH at the ends of the operating runs are very small and tend to fluctuate with changes in influent water composition.

Chemical analysis can be used but is generally tedious, time consuming and labor wasting since a series of determinations are necessary to accurately determine the end of the run. If the intervals between these analyses are too long, it is very easy to over-run the unit.

The Enditrol unit was developed by the author's company to fulfill this need for an automatic endpoint device for ion exchangers. Operation of this instrument is based upon the fact that a downflow ion exchange bed exhausts its useful exchange capacity from the top down with the bottom of the bed exhausting last. In a hydrogen cation exchanger, the calcium, magnesium and sodium ions in the raw water are replaced with hydrogen ions forming carbon dioxide, hydrochloric and sulfuric acids equivalent to the quantity of bicarbonates, chlorides and sulfates present in the raw water. During the operation run, the free mineral acidity in the cation exchanger effluent remains constant. At the end of the

* The Permutit Company, New York, N. Y.

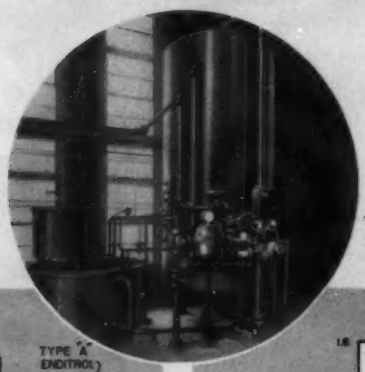
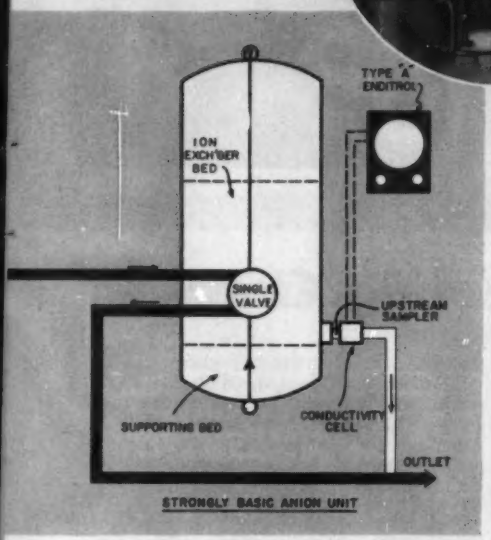


Fig. 4. Application of the "endpoint indicator" to a hydrogen cation type exchanger installation (control is box, right)



units to indicate automatic determination of endpoint (time for regeneration)

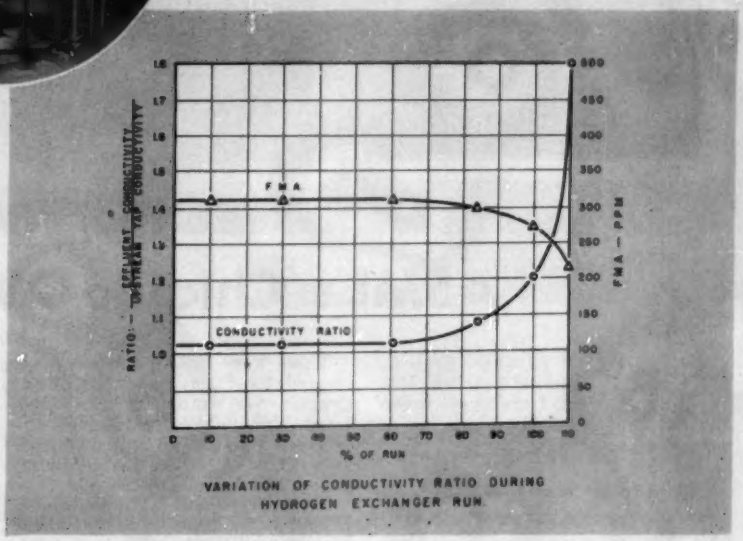

RATIO — EFFLUENT CONDUCTIVITY / UPSTREAM TAP CONDUCTIVITY
F M A
CONDUCTIVITY RATIO
% OF RUN
VARIATION OF CONDUCTIVITY RATIO DURING HYDROGEN EXCHANGER RUN

Fig. 3. Coincident variation of free mineral acidity and the upstream-vs-downstream conductivity ratio during operation of a typical hydrogen cation exchanger

run, it decreases rapidly. Figure 1 shows the variation of the effluent free mineral acidity and the hardness from start to end of a typical run.

As the cation exchange bed slowly exhausts downwardly, the free mineral acidity of the water gradually decreases as the water flows through the bed. In Fig. 2, a sample of treated water is drawn from a probe inserted in the cation exchanger bed at a point approximately 4 to 8 in. above the bottom of the bed. The conductivity of this stream is compared in a Type H Enditrol unit with the conductivity of the effluent from the bottom of the exchanger. During the run, these conductivities are approximately equal so that their ratio, as shown by the Enditrol unit, is 1.0. Near the end of the operating run, the conductivity of the probe sample will decrease because of the drop in free mineral acidity at this point. However, the effluent conductivity will remain the same resulting in a marked increase in the Enditrol ratio from 1.0 to as high as 3.0. Figure 3 shows the change in conductivity ratio at the end of the run which enables an automatic determination of endpoint.

The principal advantage of the Enditrol instrument is the fact that waters of variable composition can be handled as accurately as waters of constant composition. Changes in water composition affect both the probe sample and effluent conductivity proportionately and do not affect the conductivity ratio. The effect of rapid changes in water composition is also very slight since the probe sample is only drawn a minute at most ahead of the effluent sample.

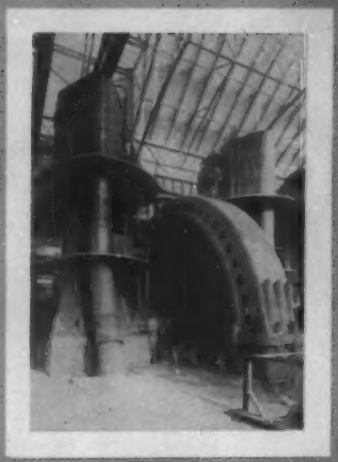
Determination of endpoint on a highly basic anion exchanger can be accomplished with a Type A Enditrol instrument. Operation for this application relies on the fact that the anions are taken up in a preferential manner by the exchanger bed. The sulfate ion is taken up first with the chloride ion next. The silicate ion (silica) is taken up last and conversely, is the first to leak through the bed when the useful exchange capacity is exhausted. Figure 2 shows how a sample of water is taken from a probe inserted in the lower portion of the anion exchanger bed. Silicic acid does not ionize sufficiently to affect conductivity to any appreciable extent, but the presence of the strongly ionized sulfuric and hydrochloric acids following the silicic acid break-through will cause an increase in conductivity of the probe sample. The probe is located at a point in the bed where this conductivity increase will occur just before the silica starts to rise in the effluent. Therefore, the end of the run is determined by monitoring only the bed probe sample for conductivity increase.

A Type M Enditrol unit is used for mixed bed demineralizers and also operates by measuring the conductivity of a probe sample which sharply increases coincident with the rise in effluent silica indicating the need for regeneration.

In all cases, the instrument is equipped with a relay to automatically signal the end of the exchanger run or automatically initiate the sequence timer for automatic regeneration of the unit.

Automatic control of the regenerating cycle involves the use of one of three types of main operating valves: hydraulically operated gate valves, diaphragm operated Saunders Patent valves or motor operated multiport valves. The nest of diaphragm or hydraulic valves is controlled by any one of several automatic pilot valves in four general classifications: solenoid, cam operated pneumatic, cam operated hydraulic and rotary disk type hydraulic.

The multiport valve was developed specifically to replace the usual five-or-six-valve nest on ion exchangers. It is automatically positioned and motor operated. Figure 4 shows a hydrogen cation unit employing an automatic multiport valve in conjunction with Type H Enditrol endpoint controls.



1880

ASME's Chicago Meeting Climaxes

ON JANUARY 18, 1880, John E. Sweet, Professor of Practical Mechanics at Cornell University, wrote the following letter to a number of prominent engineers:

Syracuse, N. Y.
11 Eldridge Street
January 18, 1880

Dear Sir,

It having been suggested by several prominent engineers that a national association of mechanical engineers would be desirable, and a meeting for the purpose of taking steps to organize such a society being in order, your presence is hereby requested at the office of the American Machinist, 96 Fulton Street, New York, the sixteenth day of February, 1880, at 1 o'clock sharp, at which time the necessary steps for organizing such an association will be made.

Any inquiries in regard to the meeting will be cheerfully answered.

Please avoid allowing this to be made public.

Very truly yours,
(Signed) John E. Sweet.

From that small beginning grew the Society that now numbers more than 40,000 members. The names of the great men who became identified with the Society in the years immediately following its founding read like a roll call of fame. There were the great inventors and designers — Edison, Westinghouse, Steinmetz, Sperry; the iron and steel makers — Holley, Fritz, Morgan, Hunt, Schwab.

There were the educators — Thurston, Morton, Denton and Humphreys of Stevens; Sweet, Carpenter, Diedrichs and Hirshfeld of Cornell; Goss and Goodenough of Illinois; Walker, Miller, Lanza and Schwamb of Massachusetts Tech; Richards, Trowbridge, Du Bois and Breckenridge of Yale; Rogers of Colby, Alfred, and Harvard; Robinson of Ohio State; Spangler and Fernald of Pennsylvania; Ricketts of Rensselaer; Hutton and Lucke of Columbia; Cooley of Michigan; Hollis of Harvard and Worcester; Flather of Minnesota; Klein of Lehigh.

There were the marine and naval engineers — Ericsson, Stevens, Cramp, See, and Admirals Isherwood, Nelville, and Harding.

There were the power plant men — Dow, Abbott, Eglin, Lieb, Murray, Orrok, Stott, and Edgar.

There were the editors — Bailey, Miller, Low, Lyne, Forney, Sinclair, Wright, and Kent.

There were the manufacturers — Babcock and Wilcox, Pratt and Whitney, Towne, Billings, Coxe, Riley, Mesta, Nordberg, Stirling, Hess, Sellers, Lodge, Nicholson, and many others.

Today, with its 40,000 members, the ASME conducts activities in 83 local sections and in student branches in 136 schools. Each member may register, according to his professional interests, in one or more of the Society's 22 professional divisions: applied mechanics, aviation, fuels, gas turbine power, heat transfer, hydraulics, instruments and regulators, machine design, management, materials handling, metals engineering, nuclear engineering, oil and gas power, petroleum, power, process industries, production engineering, railroad, rubber and plastics, safety, textile engineering and wood industries.

Why an ASME?

What was the urge that led to the founding of ASME? What were the founders looking for that could not be attained by other means?

The need existed for an organization that would bring together all who were interested in mechanical engineering problems — the industrialists who manufactured machines; businessmen and others who bought and used them, and the engineers who designed them.

The Society was conceived as a means of stimulating technical discussion and disseminating the vast fund of existing knowledge that was not being used to its full potential.

The Society's main method of disseminating information was by the presentation of technical papers at its meetings and conventions. The volume of material thus presented called for the establishment of a publication in which to maintain a permanent record. Several publications preceded *Mechanical Engineering*, which emerged in 1919 as the official monthly journal of the Society.

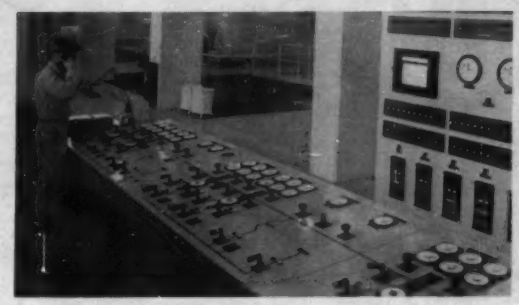
The Society's publications have grown greatly in number and volume since the first *Transactions* were issued. For example, the 1880 volume of *Transactions* contained only 18 papers. In 1954 *Transactions* had grown to 207 papers covering 1944 pages. *Mechanical Engineering* contained 1058 editorial pages.

ASME Codes for Safer Living

In the eyes of many persons, the chief work of ASME lies in the field of safety. The ASME clover-leaf stamp on a piece of equipment assures that it meets certain construction and testing standards which render it as safe as technical skill can make it.

Perhaps the work for which the Society is best known is that leading to the ASME Boiler Code. The first edition of the ASME Code for Construction of Boilers and Pressure Vessels was published in 1914. It has been given major credit for the steady decrease in boiler explosions since that date, despite the fact that the number of boilers in use has increased tremendously. In the forty years from 1870 to 1910 there were something like 10,000 boiler explosions in the United States and adjacent parts of Canada and Mexico — more than one recorded explosion in every 36 hrs. By 1910, with the use of boilers steadily increasing, the rate had jumped to between 1300 and 1400 per year.

1955



Diamond Jubilee

It was not the steady procession of disaster, however, but the occasional spectacular explosion that created the headlines and caused the greatest furore. On October 8, 1894 there was an enormous explosion at the Henry Clay Coal Mine in Shamokin, Pa., when 27 boilers exploded "like a bunch of firecrackers going off." Fortunately only six people were killed and three injured.

More tragic was the fate of the Mississippi River steamboat *Sultana*, which figured in what was the most destructive boiler explosion of all time, in terms of human life. On April 27, 1864, the *Sultana* was on her way from New Orleans to St. Louis. Below decks were some 2200 Union soldiers, recently released from military prison at Andersonville, Ga.

The men were crowded onto cots placed in cabins directly above the ship's boilers. Shortly after the vessel had left Memphis the boilers exploded, ripping the floor under the prisoners' cots. Reports differ as the number of men lost in the *Sultana's* explosion and fire, ranging from 1200 to 1450. However, it is certain that more than half of the 2200 men on board lost their lives in that sad day in the history of American marine transportation.

In 1838 President Van Buren appointed a three-man committee to look into the problem of safety measures to reduce boiler accidents. However, this, and other early attempts to keep down the number of boiler explosions were disorganized and generally ineffective. About this time various states and cities began to make their own rules and regulations for steam boilers. The result was that boiler manufacturers found themselves confronted with a maze of standards and specifications that varied from city to city and state to state. The task of devising a uniform code was made more difficult by the lack of accurate knowledge and general agreement among technical men as to what standards should apply.

It was at this point that ASME entered the picture. The Society formed a Boiler Code Committee in 1911. The first task of the committee was to get the cooperation of all groups concerned with the problem. These included the companies that manufactured the boilers, the companies that made the steel used in the boilers, insurance companies, state inspection authorities, technical schools, and — most important of all — the general public.

Today the ASME Boiler Code has been incorporated into the laws of 38 states and territories, eight provinces of Canada, Australia, Mexico City, and a number of other countries.

ASME Elevator Code

Without elevators the modern American skyscraper would have been impossible, and the ASME Elevator Code performs the same service in saving lives by preventing elevator accidents that the Boiler Code does for boilers. Today the ASME Elevator Code is the basis of laws covering elevator installations in 17 states and many municipalities. Its adoption invariably results in a striking decrease in deaths and injuries resulting from elevator accidents. For example, a few years ago Rhode Island adopted the code. Within a year elevator accidents decreased 54 per cent.

International Relations

In the field of international relations, ASME has worked closely with foreign engineering societies. It has participated in many international Congresses, and has participated directly or indirectly through joint agencies in a number of important international technical projects. It has arranged for student interchange from foreign countries, and cooperates in the joint sponsorship of foreign publications.

These, and many other activities, make the Society a vital link in the line of communication of knowledge on which our civilization depends. As Dr. Vannevar Bush, Honorary Member, ASME, and president of the Carnegie Institution of Washington, expressed it when speaking on the subject of "Communications" at the Founding Anniversary of ASME in February 1955, "Our hope rests on the gradual spread of knowledge among men, and on the assumption that with knowledge will come true wisdom. In this hope we depend on the improvement of means of communication and the gradual disappearance of obstacles to their full employment. Any man who works to extend the power and versatility of methods and machines by which one man communicates with another, any man who struggles to bring new ways of communication into uninhibited effect, can do so with a full conviction that he is laboring for the benefit of his fellow men." It can be truly said that no organization has done more to fulfil this ideal than has the American Society of Mechanical Engineers.

When you're at the ASME Meeting in Chicago, the editors of POWER ENGINEERING invite you and your friends to drop in at our suite in the Conrad Hilton Hotel for refreshments or a rest. We will be there between and after sessions from noon to midnight. There will be visitors' prizes.

At the Power Show in the Coliseum visit our booth No. 158

Fig. 1. Missing data in specifications delay proposals, waste everyone's time

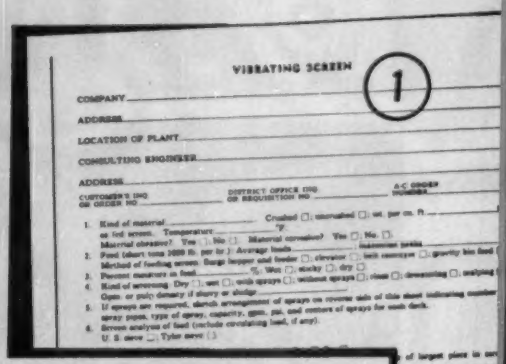


Fig. 2. Each equipment item has its own set of critical data necessary to well-designed installations. Data sheets by suppliers help you give *all* the answers

Why Make Your Suppliers Guess? Use

When you need equipment, a pump for example, you know what the unit must do in terms of end results; the supplier or manufacturer must know in terms of temperature, capacity, pressure, location, and so on to fill your needs. The *supplier's* first need is a data sheet

By H. M. KINNE*

WHEN PURCHASE of new equipment is being considered, it is absolutely imperative that *all* the engineering data — all the facts and conditions of the application — be understood by all concerned. This sounds so obvious that it need not be said, but experience has shown that all too often certain vital facts are overlooked at some point.

Assume that the equipment you need is a pump to handle a known number of gallons per minute. The exact specification for this pump, however, should be drawn up only after considering such factors as: (a) the amount of friction loss in the piping; (b) the suction and discharge heads; (c) the temperature of the liquid; (d) the specific gravity of the liquid; (e) if the liquid is special, what is the pH? (f) is it abrasive or corrosive? . . . and so on.

If these questions are not answered, it will take a great deal of time and correspondence before the supplier can answer the simple questions, "How much and when?" If the answers to the questions are just not available, there is a good chance that the buyer will end up with more pump (or other equipment) than he needs, or possibly less.

Assume a specific hypothetical (but not exaggerated!) case. A pump is required somewhere in a plant, but the only information given was:

"We require a pump for oil and have on hand a 15-hp engine we would like to use. We want to fully load this engine when it is directly connected to the pump and when pumping through 165 feet of pipe."

The following vital information was obtained only after checking back with the plant:

a. Engine speed is 1500 rpm.

b. The pump's suction would be flooded.

c. The static head due to elevation is 20 ft.

d. The 165 ft of pipe is 3 in. in diameter.

e. The oil is very viscous (the actual viscosity was not known, but would have been helpful if it were).

In this case, capacity was not important for it was a function of the horsepower rating of the engine. But with more complete data, the proper size and type of pump was determined.

Unfortunately, the same practice of supplying incomplete data can spell trouble in such simple things as a V-belt drive. The correct number and size of belts, the sheave sizes, center distances and belt lengths, horsepower, speed and so on must be known to insure getting a drive one can take for granted.

A case in point came up not long ago. A series of drives were specified on an order for six special pumps for an oil refinery. The drives ordered were reduction drives — motor speeds 1750 rpm, pump speeds approximately 2100 rpm — and when the order was received it was evident that these drives would not work. It was found that reversing the sequence of sheave diameters would produce the proper pump speeds, but this would have produced belt speeds far in excess of the 5000 fpm recognized as good practice.

As a result of all this, a completely new set of drives had to be furnished — delaying the installation and increasing its cost.

There is scarcely a single piece of equipment that does not have specific data that needs to be considered. One way to be sure that you have the necessary data is to work from a check list that itemizes the factors a supplier should know. Then you and your engineers and the firms you ask for a proposal will all have the same data to work from at the same time. A mutual understanding is much more easily reached and the correspondence is greatly reduced.

Typical Allis-Chalmers data sheets, made up for specific equipment items, carry the questions to which they need answers before making a proposal. Quite likely, you have such check lists of your own, and most of your suppliers carry their own; but the question is, do you use them?

* Allis-Chalmers Mfg. Co.

IF YOU WISH copies of any of the data sheets shown here, jot "Data Sheet" and the sheet's number on the prepaid postal card in this issue. Mail it and we will see that you get them soon

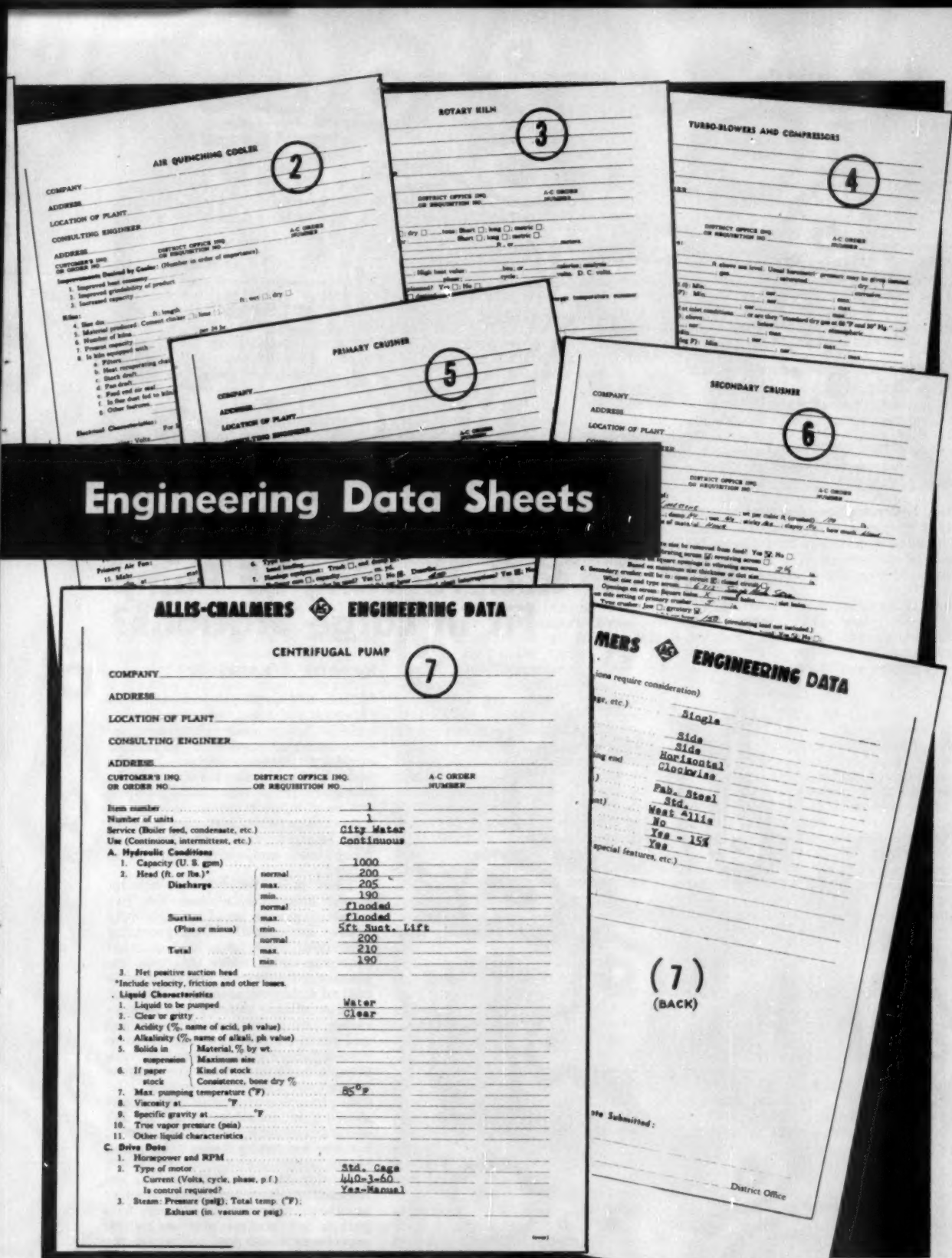


Fig. 3. Sample centrifugal pump data sheet shows all your requirements concisely, with no loopholes. Supplier can handle this proposal quickly, accurately

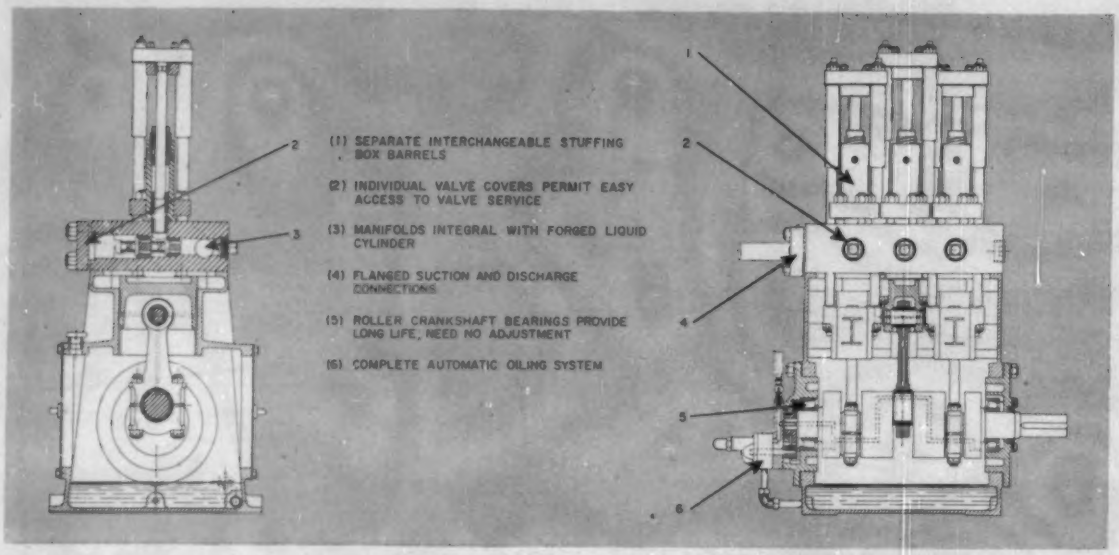


Fig. 1. Construction of a typical vertical triplex single-acting reciprocating power pump suitable for boiler feed service

Will the Reciprocating BF Pump Fit in Large Stations?

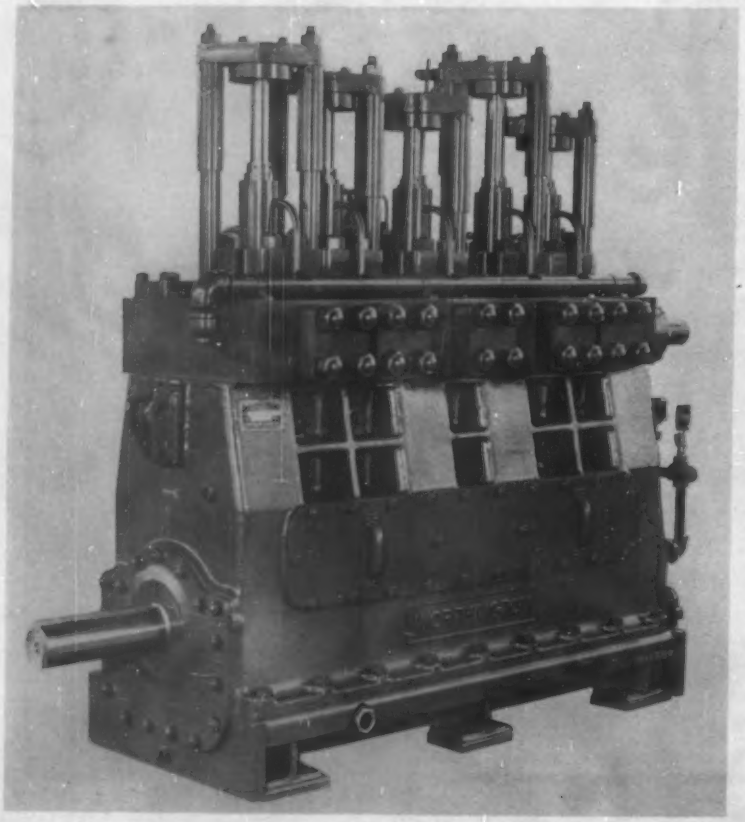


Fig. 2. Example of modern reciprocating pump suitable for boiler feed service

By **IGOR J. KARASSIK** *

THIS IS a question which comes up again and again, whenever an inquisitive steam power plant designer considers the important portion of auxiliary power absorbed by the boiler feed pump and reflects that the efficiency of the centrifugal pump is not only inferior to that of the reciprocating pump but also falls off very sharply with a reduction in plant load and, hence, in pump capacity.

There is no denying that this inherent difference between the two types of pumps would weigh very heavily in favor of the reciprocating unit were it not for a host of other problems which make this type expensive, cumbersome and difficult to control in large size units. Until such time as reliable higher speed reciprocating pump designs are developed and really satisfactory and inexpensive variable stroke designs are available, it is doubtful that the reciprocating type will see service as a boiler feed pump for capacities beyond 150 to 200 gpm. In other words, the day of a plant larger than 5000 KW served by a reciprocating boiler feed pump is still fairly far away.

On the other hand, the author has frequently advocated the use of small auxiliary reciprocating boiler feed pumps for central stations which may be at times just rolling on the line as standby — up to 3000 to

* Manager, Multistage Pump Section, Centrifugal Pump Division, Worthington Corporation

4000 hours/year in some cases. In a 50,000 KW installation of this type, the boiler feed pumps may be designed for 575,000 to 600,000 lbs per hr and yet for a large portion of the time they may be idling at as low as 50,000 lbs/hr or even less.

Such load conditions have a very unfavorable effect on centrifugal pumps for such an installation. In normal service, a high pressure centrifugal boiler feed pump can be expected to have a life of at least 60,000 hours before the internal clearances are doubled and before a complete overhaul is required. The reduced capacity load conditions may frequently fall even below the recommended minimum capacity for the centrifugal boiler feed pumps in question and the pumps may have to operate with its recirculating by-pass open. If a centrifugal pump is operated for as much as 3000 to 4000 hours/year at these minimum conditions, it is estimated that it would run no more than 10,000 to 15,000 hours before the internal wear would require that a complete overhaul be carried out.

But not the least of the advantages is that of power savings. Let us assume a typical installation intended to serve a 50,000 kw unit operating at 850 psi throttle pressure. A full capacity boiler feed pump will handle 590,000 lbs/hr of 290 F feedwater against a net pressure of 1120 psi at its rated conditions and will absorb 1070 bhp. When reduced load conditions require 50,000 lbs/hr to the boiler, this flow is less than the permissible minimum for such a pump and the pump will operate with its by-pass open. Even if we were to allow a 20 F temperature rise through the pump, the minimum flow would be of the order of 75,000 lbs/hr. When operated at this capacity and at a reduced temperature of, say 230 F, the bhp becomes 665.

Action at Reduced Loads

The reduced load conditions of 50,000 lbs/hr. can, however, be met with a reciprocating pump which, because of its inherent characteristics, will develop only the pressure required by the system head. Assuming an efficiency of 85 per cent for the reciprocating pump, and a required net pressure of 950 psi, its power consumption will be 68 hp. Adding gear and hydraulic coupling losses, the power consumption rises to about 75 hp. This represents a saving of 590 hp or 475 kw when compared to the inefficient operation of the centrifugal pump at such reduced flows.

Since the power pump is a positive displacement type, its delivery cannot be controlled by a throttling valve in the discharge as in the case of a centrifugal pump. Volume control of a reciprocating boiler feed pump can be effected in several ways. The pump can be permitted to run at fixed speed and, therefore, deliver a constant capacity. A by-pass line is provided in the pump discharge, leading back to the suction supply. A diaphragm operated throttling by-pass valve is installed in this by-pass line, being made responsive to changes in the requirements of the boiler. Essentially, this valve is similar to the normal feedwater regulator, except that its action is exactly reversed: it opens wider on reduction of demand and closes on increase in load.

Valves Need Improvement

Unfortunately, up to the present, experience with such valves has not been too encouraging. The pressure pulsations from the discharge of a reciprocating pump have been known to cause chattering and slamming, even with a pulsation chamber on the discharge. It is possible that improvement in the operation of these valves may be obtained by providing them with some form of dash-pot or damper on both the upward and downward stroke of the valve to minimize the effect of pump pulsation.

Another way to get variable capacity from a reciprocating pump has been to use variable stroke pumps. While this article is not intended to be a discussion of variable stroke design, it should be mentioned that the cost of such pumps is relatively high, their maintenance costs are higher than those of fixed stroke designs and other means may be found more economical. It would appear that the most satisfactory means for varying the capacity of the auxiliary reciprocating boiler feed pump would be to install a variable speed device such as a hydraulic coupling between the motor and the speed reducing gear. Such a device would permit a speed variation — and hence, a capacity variation — from 100 down to 25 per cent. The latter is as slow a speed as is recommended for this type of pump, in order to provide proper lubrication. Should boiler loads occur requiring capacities under those obtainable at 25 per cent speed, a by-pass would be used between the pump discharge and the suction supply, with a pressure reducing orifice sized to handle this minimum flow of 25 per cent. The valve in this by-pass line would be either fully closed or fully open and its action would be made automatic.

Pump Should Be Derated

In selecting the reciprocating boiler feed pump for such auxiliary service, it should be remembered that this pump will be required to operate continuously for long periods of time and that extreme reliability is desired. The pump should therefore be derated from its maximum rating by as much as 30 to 40 per cent. In other words, its design speed for the desired capacity should be selected at not over 60 to 70 per cent of the pump rated speed on cold service.

There is no great need to go into actual details of construction of the reciprocating pump designed for boiler feed service, other than to indicate a few important details. For instance, while heat treated type 420 stainless steel plungers with 500 Brinell have seen service in the past, it appears that Colmonoy coated plungers are preferable. This preference is based on the greater hardness of this material, greater corrosion resistance and lower coefficient of friction against packing. In order to smooth out the pulsations from the reciprocating pump, it is recommended that an electrically heated discharge cushion and a steam jacketed suction cushion chamber be included in the installation of such a pump on boiler feed service.

Reciprocating Pump Advantages

The typical construction of a vertical triplex single acting power pump suitable for boiler feed service is illustrated in Fig. 1. Figure 2 shows a typical modern reciprocating pump suitable for boiler feed service.

In summing up the advantages accruing from the installation of an auxiliary reciprocating boiler feed pump whenever it is expected that extended plant operation will be encountered at very reduced loads, the following points should be evaluated:

(1) The power requirements of the reciprocating pump will be but a fraction of those of the centrifugal unit and the resulting savings can be translated into quite a respectable figure.
(2) The use of an auxiliary reciprocating boiler feed pump would increase the useful life of the centrifugal pumps between complete overhauls by approximately 4 to 6 times.
(3) Even if no consideration is given to the increased wear of a centrifugal pump operating at excessively light loads, the installation of the axuiliary power pump will cut the actual yearly operating hours of the centrifugal pump by the number of hours during which the auxiliary pump can handle the total plant load.
(4) In most cases, the use of the auxiliary boiler feed pump will eliminate the need of operating the recirculating by-pass of the centrifugal pump since the latter would no longer run at low loads. This would reduce the maintenance costs of the by-pass valve and of the recirculating piping itself.
(5) Because the auxiliary power pump can be used as a boiler test pump, it eliminates the need of purchasing and installing a power pump for this service. This may represent a saving of as much as $5,000 to $7,500 in a high pressure steam station.

Against these advantages must be weighed the initial cost of the auxiliary unit and the cost of installing the pump, including the foundation and the controls. In the author's opinion, it is remarkable how often the balance will come out in favor of an auxiliary boiler feed pump of the reciprocating type.

Two Hydrazine Users Answer Questions On New Oxygen Scavenger

Hydrazine once starred as a rocket fuel. Now, on paper, it looks like a good oxygen scavenger for boiler feedwater. Two of its few users, in reply to a POWER ENGINEERING questionnaire, indicate good results, but emphasize that they still have questions of their own

NOT MANY power stations have made use of the promising new oxygen-scavenger, hydrazine. There are several reasons for this: The materials they are now using do a good job; there is not a very reassuring backlog of experience with the new material; men are reluctant to bring a potential explosive into their plants; and, if they sit tight long enough, someone else will try it for them and report their results in the trade periodicals (see pp. 80–84, POWER ENGINEERING, September 1955).

This "let George do it" attitude is here to stay, and is understandable. Fortunately, however, the pioneering spirit is equally entrenched. One of these early birds reported last month on his station's experience with hydrazine; this month, two other plants (identified here only as Plant A and Plant B) reply to some of the questions POWER ENGINEERING editors have heard most often about this material. Their answers are not conclusive evidence of hydrazine's future in feedwater treatment, a point which they requested us to emphasize, but they are based on actual experience.

If you have questions about hydrazine not answered here, or have experience to report that might help others, please write to the editors. Also, if you wish a copy of the commercial bulletin on hydrazine, write this request to the editors.

1 What concentration of hydrazine have you found most suitable for oxygen scavenging in your boiler feedwater?

Plant A: Most suitable concentration of hydrazine in the boiler feedwater ranges between 0.1 and 0.2 parts per million, usually 0.15.

Plant B: Hydrazine feed concentrations of 20–60 parts per *billion* are used at present. We have not had sufficient experience to determine an optimum value.

2 How do you determine the concentration and how do you test the steam output of the plant to determine whether any of it [hydrazine] has carried over or not?

Plant A: Hydrazine concentration is determined colorimetrically by adding a solution of p-dimethlaminobenzaldehyde in alcohol and hydrochloric acid to the sample containing hydrazine. This method is described in Analytical Chemistry, Vol. 24, No. 12 (December 1952), page 2006.

The amount of carry-over is indicated by conductance measurements of the condensed steam, or it can be determined by the colorimetric method.

Plant B: A colorimetric test specifically for hydrazine is used. We test for hydrazine at the superheater inlet to determine carry-over of hydrazine in the steam.

3 Have you any data as to its toxicity? This would be a factor if the steam were used in industrial processes; i.e., those involving food.

Plant A: Hydrazine is toxic and can be absorbed through the skin. Any possibility of its getting into food should be eliminated.

Plant B: The only data that we have on toxicity is supplied by the manufacturer. It stresses avoiding the inhaling of hydrazine fumes and contact of hydrazine with the body.

4 What equipment do you use to store, handle and feed hydrazine?

Plant A: The 85-per cent hydrazine hydrate is shipped in stainless steel drums from which it is transferred as required to a stainless steel tank, which supplies a Milton Roy "Minipump" and (is) fed to the feedwater leaving a deaerating heater.

The stainless steels recommended are types 302, 303, 304, 321, and 347. Type 316 stainless steel, Hasteloy C and other molybdenum-containing alloys are not recommended.

Plant B: Hydrazine is stored in the stainless steel drums in which it is purchased. The tubing in the hydrazine feed system before it is diluted to 20–60 parts per billion is stainless steel or "Tygon." The fittings are all stainless steel. At concentrations of 100 parts per billion and lower, copper tubing and brass fittings are used.

5 **What precautions are needed in storing, handling and feeding hydrazine?**

Plant A: Hydrazine should be stored in a cool, ventilated space and preferably out of contact with air. In handling, contact with the skin or eyes, and inhalation of the vapor, should be avoided. Feeding can be done with equipment made of approved materials of construction. In feeding, too large an excess of hydrazine over the theoretical requirement apparently breaks down almost completely to form ammonia.

Plant B: The persons handling hydrazine wear gloves and face masks. They are also cautioned to avoid inhaling the fumes of hydrazine.

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6 **Have you any figures on the comparative costs of using hydrazine, as compared with sodium sulphite, as an oxygen scavenger?**

Plant A: No cost comparisons of hydrazine and sodium sulphite have been made by us under similar conditions, but comparisons have been published indicating hydrazine to be the more economical.

Plant B: To date, the cost of feedwater treatment with hydrazine is approximately double the cost of sulphite treatment.

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7 **Have you any data on the effect of hydrazine on boiler cleaning or any other maintenance problem?**

Plant A: Although we have no data on the effect of hydrazine on boiler cleaning or other maintenance problems, indications are, in the short time it has been used here, that it will do much to maintain boilers in the cleanest condition and minimize any maintenance that would be caused by oxygen corrosion. If by "boiler cleaning" you mean acid cleaning, we have never used it for boilers.

Plant B: We have no information on the effect of hydrazine on boiler cleaning. Treatment was started on our No. 2 Unit in November, 1954.

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8 **Would any of the chemicals normally found around a power plant react explosively with hydrazine?**

Plant A: Quoting from the Mathieson Corporation bulletin: "Hydrazine solutions are very stable and non-explosive. They have been heated above 570 F with little decomposition. Aqueous solutions are not sensitive to impact, friction or detonation.

"Hydrazine is combustible. The vapors, from solutions containing more than 40 per cent hydrazine, burn in air with a blue flame. It is an endothermic compound and may, therefore, be expected to undergo decomposition under certain conditions with the release of considerable energy.

"Hydrazine is a strong reducing agent which in high* concentration may react violently with many oxidizing agents."

*** Editor's Note: Until some of the adjectives in such reports are replaced with quantitative terms, it might be very wise to keep hydrazine and your acids in different locations.**

Plant B: We have no information about the reaction of hydrazine with chemicals normally found around power plants. The hydrazine that we purchase is 35 per cent solution by weight in water.

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9 **Could hydrazine break down to form enough ammonia to endanger copper and brass fittings or heat exchanger tubes?**

Plant A: Theoretically hydrazine, if fed in great excess, might break down enough to form ammonia in quantities detrimental to copper and brass fittings or heat exchanger tubes. However, it would neither be economical nor desirable to use any such quantity. If used correctly, the possibility of such damage is remote.

Plant B: We have no information at this time concerning the breakdown of hydrazine to ammonia.

Summary Comments

Plant A: Much has been and is being learned about the use of hydrazine in feedwater treatment, and its use is increasing — especially where higher pressures and temperatures are involved.

Plant B: Our operating experiences show similarity with data obtained at the Springdale Station of West Penn Power Company (Paper No. 54-A-261 presented before ASME, December, 1954). In both stations, residuals were found in the boiler water on the first day the hydrazine was used. This is in contrast to Duke Power Company where several weeks were taken to establish hydrazine residuals.

The order of magnitude of concentrations of hydrazine at various locations in both stations (Plant B and West Penn's Springdale) was the same. In addition, our dissolved oxygen tests have shown hydrazine and oxygen co-existent at temperatures of 85-90 F. The samples taken at the discharge of the No. 4 heater show a considerable decrease in hydrazine concentration compared to the hydrazine concentrations at the condensate pump discharge.

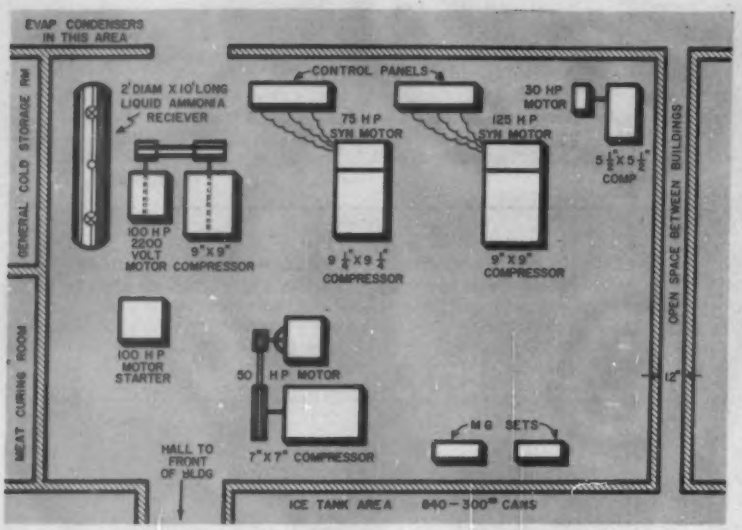


Fig. 1. Compressor room, scene of the explosion, in the neglected ice plant

Neglected Trouble Warnings Cause

You can't say there were no warnings; there were two years of them. Then, to everyone's surprise, a compressor blew its top and set off a king-sized explosion. The plant manager admitted he was no expert and took his operators' assurances that the signs were normal

By C. T. BAKER *

SOON AFTER the 1953 ice season was under way, the manager of a 70-ton ice plant noticed that at times two of the five vertical, single acting, ammonia compressors appeared to be handling considerable liquid. He reported his findings to the plant engineer, explaining that previously the discharge pipe had always run hot and that frost had never formed on the compressor cylinders below the suction in-take connection. He was assured by the operators on both the day and the night shifts that the condition was not at all unusual, that compressors often operate for periods with cold discharge lines and heavily frosted cylinders.

Being inexperienced in the field of ice manufacture and having been associated with the plant for only a few months prior to 1953, the manager accepted the explanation of the men as he had confidence in their ability as ice plant operators. One man had been employed in the operation of ice-making plants for a great many years and the manager felt that both knew what they were talking about.

Things rocked along in this manner for the remainder of that season and for the greater part of 1954. By 1955 however, it had to be admitted that in spite of all efforts, the plant would not produce capacity. It was noticed too that liquid carry-over to the compressors from either the freezing tank coils or the coils in some of the cold storage rooms, had reached the point where the compressors were pounding badly and the discharge pipes constantly ran cold. Even with this indisputable evidence of trouble, no investigation was made to determine the cause of liquid carry-over or loss in ice output.

Late in the afternoon on June 20th of this year, the inevitable happened. With all compressors on the line (at least two of which operated at 300 r.p.m.), a cylinder head on a 9¼ x 9¼-in. compressor was knocked off, scattering valves, parts of the piston, discharge valves, and safety head in all directions. Fortunately, no one was in the machinery or the tank room at the time, so it is not known how long the compressors continued to run after the cylinder was wrecked. Release of ammonia in the building was estimated to be two thousand pounds.

While the ammonia vapors and liquid were still pouring into the building, a terrific explosion occurred and fire broke out. Much of the roof on the compressor and tank rooms was blown off; part of the walls of the two cold storage rooms were cracked; and the better part of the plant ammonia and water piping was wrecked.

Damage from fire was also severe. It included loss of the entire lighting system, one 75 H.P. motor with starting panel, practically all of the power wiring, belting and other equipment, and great damage to that equipment which was not completely destroyed.

On equipment, the total loss and damage from fire and explosion amounted to approximately $25,000. The building damage will also amount to a considerable sum.

I was engaged to determine the extent of loss and damage, as well as the cause of the accident. The accompanying sketch shows the general arrangement of the machinery room and the location of the freezing tank and storage rooms in relation to the machinery room.

One compressor had been put back into service before I was able to begin my investigation at the scene of the trouble. While watching the performance of this belt driven 9 x 9-in. compressor, I noticed that it was handling large amounts of liquid and the lower half of the two cylinders remained heavily frosted for several hours, while the discharge line leading to the evaporative condensers was stone cold. In addition, the ammeter on the supply circuit behaved in a most erratic manner.

Cause of Trouble

The strictly modern ice freezing tank was built by one of the leading refrigerating machinery manufacturers and it had performed in an entirely satisfactory manner until the beginning of the 1953 ice season, so there was no question of blaming the manufacturer for faulty equipment.

Further observation of the performance of the compressor convinced me that the trouble was caused by a

*Consulting Engineer

defective float or a damaged float expansion valve which were contained in a float chamber. A full size by-pass and a manual expansion valve permitted the float chamber to be cut out of service and the coils to be fed by hand. After placing the tank coils on manual control and adjusting the expansion valve to maintain a constant or uniform evaporating pressure, no further trouble was experienced from liquid carry-over. In the meantime, a complete new float and valve assembly was ordered by wire to be shipped Air Express.

When the float chamber was pumped out and the old float removed, it was found that the float had a bad crack near the point where it fastened to the stem which actuated the float expansion valve. This, eventually, allowed the float to fill with oil and finally to become so heavy that it could no longer float in the liquid. Naturally, it settled to the bottom of the float chamber and held the expansion valve in the wide open position. Permanently on the bottom, it afforded no way to prevent the coils from completely filling with liquid and overflowing into the liquid accumulator above them. The accumulator was 30 in. in diameter by 5 ft high and was set at an elevation slightly above the suction inlet of the compressors.

It is evident that with the coils and the accumulator filled solid, it was an easy matter for the liquid to syphon over to the compressors in almost a solid stream.

There were those at the scene of the accident who claimed that it was impossible for a mixture of air and ammonia to explode. What those wise folks overlooked was that the ammonia system was loaded with oil and that anhydrous ammonia, oil and air in the correct proportions can become an explosive mixture of the first magnitude.

The spark, or source of the ignition in this instance, was quite likely the electric wiring or other electrical equipment damaged by the cylinder head failure. Or, it could have been the result of sparks or flame propagation caused by the impact of the compressor piston striking the broken valves or other interior equipment of the cylinder.

With nearly two years' warning of trouble ahead, nothing was done to prevent the accident which occurred in 1955. It is quite evident that the partial destruction of this plant can be attributed to ignorance or indifference on the part of the plant operators.

$25,000 Ice Plant Fire

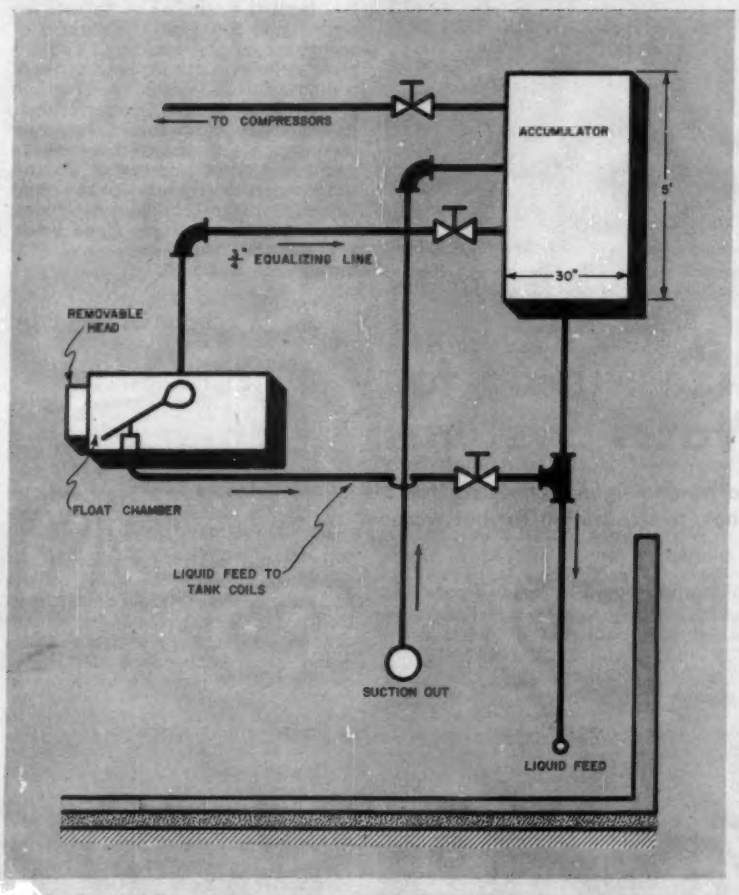


Fig. 2. Cracked float sank in chamber to hold float valve permanently open. This flooded the coils and accumulator, which syphoned over and into the compressors

The Small Refrigerating Plant

In another factory, because of neglect, the high pressure cut-out in a small refrigerating plant had become inoperative. Due to high condensing pressure, one of the dual safety valves on the liquid receiver failed to close tightly, so it was cut out of service and the companion safety cut in. To avoid having the companion valve develop trouble too, it was "adjusted" for a higher discharge pressure. Of course, no one knows how much higher, and there is no way of telling, but according to the statements of those whose duty it was to "look in" on things occasionally, "that didn't matter."

Recently, one of the two compressors on the line blew a cylinder head gasket, causing the loss of a great deal of the ammonia charge and a partial shut-down of the plant. According to a mechanic who said he looked at the high pressure gauge just before the gasket blew, the condensing pressure was 275 pounds. No, the safety valve did not open, and the high pressure cut-out did not act to stop the compressors before they destroyed themselves.

Just how close this installation missed a thoroughly destructive accident will never be known. Most of the fittings in this plant are quite old — some have been through a fire and a few pieces are cast iron and not intended for use with ammonia.

Cause: Air and Dirt

The cause? A system full of air and spray nozzles on the evaporative condenser that failed to maintain a film of water over the condenser coils. It was impossible, as the spray nozzles were nearly completely plugged with dirt and trash. A spray pump suction strainer had been supplied with the evaporative condenser but it had rusted out over the years and had been removed, and a new strainer had never taken its place.

Why was there so much air in the system? That is another interesting story. When a defective valve on a branch suction line had to be replaced, the system was pumped down to a vacuum and a new valve was installed. When this operation was completed, ammonia was turned back into the system and the plant was put back in operation without air being evacuated from the low side.

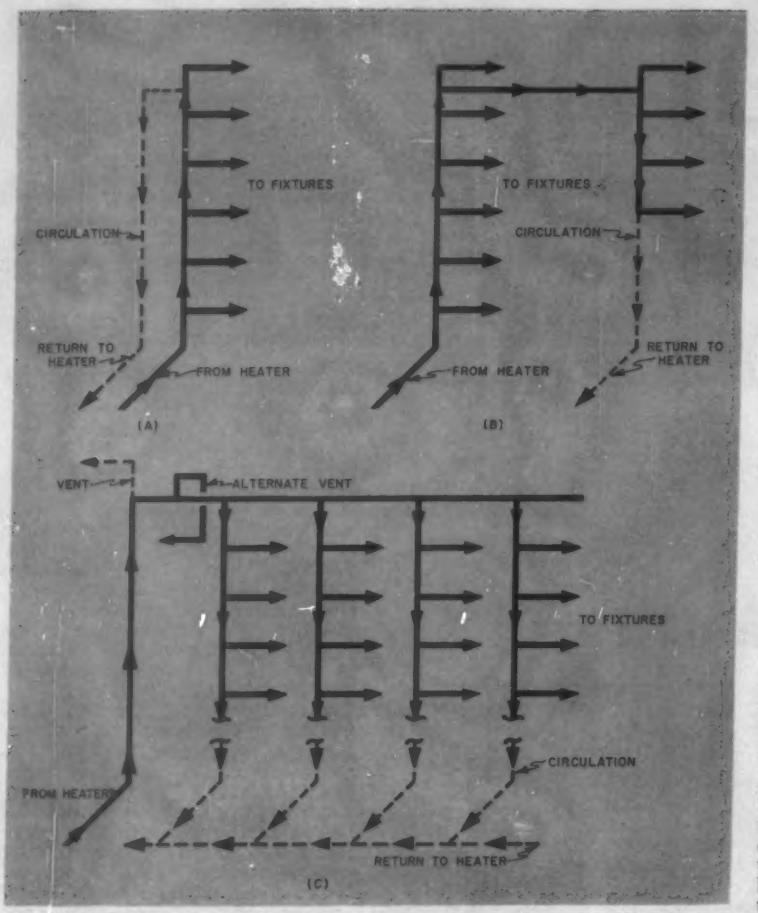


Fig. 1. A. Up-feed hot water system with circulation line below top fixture. B. Combined up-feed and down-feed system with circulation pipe connected to the heel of the down-feed riser. C. Down-feed system, circulation and vent piping

How to Size Piping for Hot Water Systems

In our October issue we explained how to figure pipe sizes for a cold water system. Here we show how to size piping for hot water

Table I. Two ways of computing amount of hot water used by building occupants

Type Building	Fixture Demand, gph per fixture at 140 F					
	Lavatories	Showers	Slop Sink	Dishwasher	Demand Factor	Storage Capacity Factor
Industrial	12	225	20	20 to 100	0.40	1.00
Office	6	—	15	—	0.30	2.00
Hospital	6	75	20	50 to 150	0.25	0.60
Hotel	8	75	30	50 to 200	0.25	0.80

Demand Based on Building Occupants	Gal per day per person
Industrial	5
Office	2
Hotel	40

AS WITH COLD water systems, hot water supply piping can be either up-feed or down-feed. However, in addition to the usual risers, a circulating pipe is also used as shown by Fig. 1. This pipe allows water to return to the heater continuously, thereby providing hot water at each fixture whenever it is needed. Besides provision for circulation, venting of the hot water system is also necessary. Either an automatic float type air vent or special arrangement of the piping can be used to remove air from the system. The latter method is generally preferred in small systems because it is cheaper.

Thus, in Fig. 1A, the circulation pipe is connected to the riser below the top fixture. Any air which enters the system will accumulate at the top of the riser and will be relieved when the highest fixture is used. This accounts for the sputtering sometimes encountered in top floor fixtures. In Fig. 1B, a similar arrangement provides for what might be termed automatic venting. With an overhead supply main as in Fig. 1C, either an air vent or a fixture vent can be used as shown.

Hot water used by building occupants can be computed in two ways; 1 — from the number of fixtures installed, and 2 — from the number of occupants in the building. Table I gives sufficient data for both types of computations. Although each method gives reliable results, demand loads based on the number of fixtures are used more often because it is easier to count the exact number of fixtures than to accurately estimate the number of people in the building. Hence, the illustrative example given below will use the fixture method of estimating demand load.

Example: Determine the hot water demand for an industrial plant fitted with 10 lavatories, 6 showers, and 5 slop sinks. What capacity heater and storage tank is required?

Solution: Using demand figures from Table I,

10 lavatories at 12 gph = 120 gph
6 showers at 225 gph = 1350 gph
5 slop sinks at 20 gph = 100 gph

Possible demand load = 1570 gph

This is the maximum possible demand which might be made on the system. However, experience shows that the maximum demand is seldom encountered in usual systems. A demand factor is therefore used, being in this case 40 per cent, as shown in Table I. Hence,

Probable max. demand = 1570 (0.40) = 628 gph
Heater capacity = 628 gph
Storage tank cap. = 628 (1.00) = 628 gph

Sizes of hot water pipes are determined in the same way as shown for cold water piping in the October issue of POWER ENGINEERING. It is usual practice to make the hot water re-

turn pipe ¾ in. for small and moderate size industrial buildings and 1 in. or larger where return runs are long. Special calculations are necessary for large systems; they will not be given here because they are not often used. To control circulation flow rate, a globe valve should be installed in the hot water return pipe. Then, if necessary, circulation rate can be increased during periods of extremely cold weather and reduced during hot weather.

To permit maintenance of hot water systems, each riser should be valved near the bottom. Return lines are also fitted with a check valve near the bottom to prevent reversal of water flow when a fixture is in use. These valves increase pressure losses in the piping but the operating flexibility obtained makes them worthwhile. It is good practice to keep branch pipes as short as possible because heat losses are reduced and less water must be run from the fixture before the desired temperature is obtained.

Storage capacity necessary is based on the total demand during the day, the maximum demand during any one hour, and peak load duration. Industrial plants usually require more storage capacity than other types of buildings because duration of the peak load is shorter. Only about 75 per cent of the water in a storage tank can be drawn off at the proper temperature. The remaining water cannot ordinarily be used because it is cooled below the proper temperature by the incoming makeup water. Required storage tank capacity is usually computed when estimating demand load.

Since steam heating boilers are often used to raise the temperature of water, the added load caused by the hot water heater must be computed. In general, to heat one gallon of water per hour through a 100 F range, a quantity of heat equal to that used by 4 sq ft of equivalent direct radiation has to be supplied. This figure is conservative, and includes an allowance for various losses which are encountered in usual systems.

Note that the heater must be able to increase the temperature of 628 gph from that at supply to the usual 140 F used in industrial plants. Also, the storage capacity must be a minimum of 628 gal. Equality of these two figures results from a unity value of the storage capacity factor. In an office building, for instance, storage capacity would have to be twice as great as the probable maximum demand because the capacity factor is 2.0.

Where water for process use is taken off the hot water supply risers the quantity used per unit time should be added to that required by fixtures in the building. Then the supply pipes are sized by making the same assumptions as in Part I of this article.

Plant engineers who must design, or check water system designs, can readily do so by using the data in these articles. Complete analysis of water services for a building requires, of course, more extensive calculations than those shown here. However, each calculation is simply a repetition of one or more of those given in the illustrative examples. Plant engineers usually have a good conception of what they want from a water system and when they "figure" it themselves, performance is close to that desired.

Remarkable Miniature Tube Made of Ceramic, Steel

RADICAL NEW CONCEPT in receiving tube design has been announced by General Electric and demonstrated in the form of a tiny "micro-miniature" ceramic triode for UHF television sets.

The micro-miniature triode — 6BY4 — is an all metal-and-ceramic tube about ¾ in. long and 5/16 in. diam. Preliminary ratings on this particular tube are based on an operating frequency of 900 megacycles. Development work indicates production models soon will be available with a noise factor of approximately eight decibels, and a power gain of approximately 15 decibels when operating at this frequency with a bandwidth of 10 megacycles.

Practical development of the 6BY4 in Kentucky followed several years of fundamental research in tube design, ceramic material and titanium at the G. E. Research Laboratory in Schenectady, N. Y. Although the tube features micro-spacing of elements and a grid of approximately 1000 turns per inch, the micro-miniature design permits the development of simplified production techniques which should allow a relatively low price.

While the tube cathode normally is heated with a filament in the conventional manner, a startling demonstration with a blow torch applied to the outside of the tube showed how it also will operate when heated by an external source.

G-E engineers see the possibility of a complete line of these tiny electronic tubes from diodes to complex multi-element tubes. Possible applications include mobile and industrial communications, airborne and mobile radar, industrial controls, guided missile controls, nuclear power controls — possibly even man-made satellites.

Photograph shows small size of the new tube. It is ⅜ in. long by 5/16 in. diam

In general, any electronic equipment requiring motion, high temperature, restricted space, automatic assembly or UHF performance has a potential requirement for micro-miniature tubes.

The design and manufacture of micro-miniature ceramic tubes represents a complete departure from conventional techniques of quantity tube manufacture. New materials, processes and assembly methods were necessary to produce tubes such as the 6BY4.

The grid assembly is typical of this fresh approach. This grid is made from tungsten wire only .0003 in. diam — so fine it is virtually invisible under normal room lighting. Nevertheless, the wire is wound and brazed to a small tungsten washer at a pitch of 1000 turns per in. — representing a new degree of precision in quantity tube manufacture. Special machinery developed by G-E engineers performs this delicate operation.

Extensive ceramic research was necessary to develop the material used for spacers in this tube. The search for a low-loss ceramic of appropriate expansion characteristics, dimensional stability and vacuum-tight sealing characteristics required investigation of materials not previously used in vacuum tubes.

Exhaust and sealing techniques used in the production of these tubes are unique in the field of vacuum tube manufacture. The resulting seals remain vacuum-tight at temperatures in excess of 700 C.

The development of the 6BY4 and subsequent ceramic micro-miniature receiving tubes embraces research in metals and ceramics, development of new exhaust and sealing techniques, design of new tube-making machinery and investigation of new processing methods. The result is a tube of completely new construction and greatly improved physical and electrical characteristics.

cut along this line

Power Engineering handbook

The Gas Turbine Primer

Part II

GAS TURBINES are developing fast and will soon be used by industrial and utility power plants as a matter of course. This primer is intended to dispel some of the misconceptions about such units — not to qualify the reader to design them. It is a qualitative discussion and avoids quantitative aspects as much as possible. Textbooks treat the latter adequately.

Part I of this primer was devoted to a discussion of the more common cycles, the more common components, and the factors that influence efficiency in the cycle up to the turbine wheel. Part II will discuss the turbine wheels, accessories, control, and some variations of the basic cycles.

Types of Turbine Wheels

Turbine wheels may be constructed so that the hot gas flows parallel to the shaft (*axial flow wheels*) or inward toward the shaft (*centripetal flow wheels*). In either case, the gas may expand in one single stage or it may expand partially through each of several stages.

These wheels get mechanical power from gas by expanding it through a nozzle so that it bounces off the moving blades, or by expanding it through the moving blades so that its backward kick is directly against the moving blades. The first type turbine is called an *impulse* turbine while the second is called a *reaction* turbine. Centripetal wheels operate by reaction, but the axial flow wheels may be impulse, reaction, or both at the same time. Most turbines are of the axial flow type and utilize both impulse *and* reaction principles so that they can keep high efficiency over a wider operating range.

Permissible temperatures at which these wheels may operate affect the speed, efficiency, and power each wheel can develop. Temperature also affects the turbine's life.

Turbine cycles are operating so close to the absolute maximum temperatures permitted by the blade materials that a new factor has become important. This factor is *creep*, which identifies the stretching that takes place in metals subjected to pulling loads over a period of time. Normally we only concern ourselves with the stretching that occurs when the load is first applied, but metals operating with a steady load and a high temperature stretch continuously as long as the load is maintained. This load is primarily due to the centrifugal forces that tend to throw the blades outward and the counterforce exerted by the wheel.

Limiting temperature, then, is not the melting temperature of the blade metal, but is the temperature at which the blade will operate within acceptable "time-stretch" or creep limits. Since time is involved in the stretch, it becomes apparent that time becomes involved in the limiting temperature. If the turbine is to be operated continuously for long periods without replacement of the blades, a lower temperature must be resorted to; short-life machines (such as aircraft jet engines or gas turbines used in emergencies only) can tolerate higher temperatures because they operate less time at that higher temperature.

fold along this line — outside edges toward you

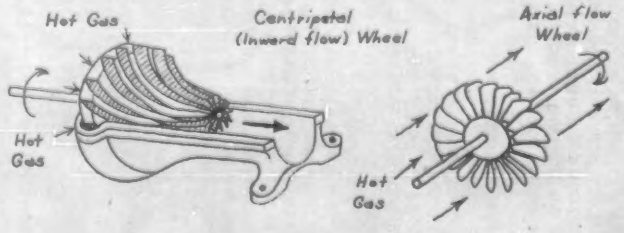


Fig. 14

Centripetal (inward-flow) wheels made of the same materials as the axial flow blades can operate at higher temperatures for several reasons. The most obvious reason is the greater area at the root of each flute (corresponding to the blade in axial wheels). All the centrifugal force acting on an axial flow blade or centripetal flow flute is concentrated where the blade or flute joins the wheel. The junction area is larger for the long curved flutes, hence the load per square inch is lower and the stretching at the critical root area is less.

But the centripetal turbine (which is little more than a centrifugal type compressor run backwards) is most efficient when run at very high speeds. As a result, the centripetal wheel will usually be operated at about the same temperature as the axial flow wheel, but it will spin faster. This makes the centripetal unit very desirable for small turbines using centrifugal compressors, because the smaller the diameter of a centrifugal compressor wheel, the faster it must rotate to do a given job. Centrifugal compressors and centripetal turbines are becoming quite common running-mates in the smaller units.

Blade materials in current use are limited to about 1600–1650 F (turbine inlet temperature), but for the low-maintenance machines this same material may be operated at about 1350–1400 F. Experimental metals are in existence that can be operated with considerable success at 1900–1950 F, but are not in general use. The same class of metals (the titanium carbides) give promise of inlet temperatures of over 2000 F.

Blade Cooling

Since the temperature of the blade is important to its life, why not cool the blade? Of the two types of turbine wheels, the centripetal wheel is much the easier to cool. Large turbines, however, usually employ several stages of the axial flow wheels and their cooling requirements are greater because of the higher root stresses. The most common way to cool axial blades is to form hollow blades and pass cooling air through them from the roots outward (see Fig. 15). This has the advantage of bringing the coldest air, and the greatest cooling, to the root area where the stress is greatest. A "fringe benefit" of this arrangement is that the blades, being hollow and lighter, impose less load on the roots.

For purposes of blade cooling, the ideal turbine blade material is one which has a very high thermal conductivity (allows heat to flow through the metal freely) but which is a very poor absorber of heat. Thus, the small amount of heat that enters the blade from the gas will flow so quickly to the cooling air that it does not accumulate and significantly raise the metal temperature. Such effects have been achieved to a limited extent with surface coatings that have a low heat conductivity, but the heat conductivity of the blade metal itself is difficult to control without seriously altering

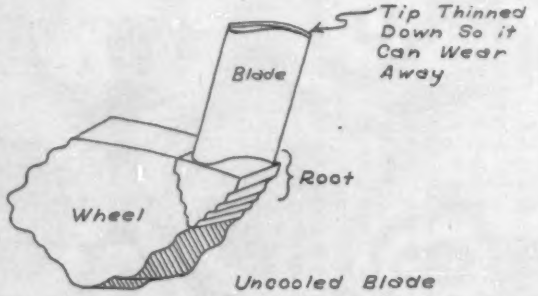


Fig. 18

turbines built after about 1935 is that the turbine continues running after the crank is disengaged. Turbines built after about 1945 are distinguished by their ability to continue running after a load is applied. Finally, the really distinguished turbines of today will continue carrying their loads for several thousand hours.

To get back to the subject, however, we now have a turbine running under its own power, supplying its own fuel to the fuel nozzles, and lubricating its own bearings. Two main problems remain: We must prevent the turbine from accelerating so fast that it throws itself apart and we must prevent it from melting itself by burning too much fuel. So we need a *fuel control.*

It would be impractical to discuss all the different types of fuel controls in a primer, but we can visualize a typical device from its requirements. There must be some temperature sensing element at the turbine inlet and there must be some speed sensing element on the turbine wheel. If either of these quantities (speed or temperature) goes above the safe or desired point, the fuel control must be "informed" by the sensing element and start trimming down the fuel being burned.

Figure 21 shows a schematic fuel system with speed and temperature control. The temperature "control" part of the system is usually, as in this case, a means for warning the operator that the danger temperature is being approached plus a complete shut-off mechanism which acts if the warning is ignored. It does not, as a general rule, meter or restrict the fuel flow as the gas gets too hot; it merely shuts down the engine. Speed control, however, calls for delicately varying the valve setting as the shaft speed varies.

Note the odd contraption in Fig. 21 called the "speed governor." There are many variations of this device, but most of them use the centrifugal effect shown here. Visualize the turbine during a start-up as it gathers speed. Since the speed governor is geared directly to the turbine shaft, it will speed up proportionally. The two balls hinged to this shaft will tend to be thrown outward by centrifugal force as they rotate faster but, since they are attached at the top, will merely swing upward. In doing so, they pull the "spool" up with them, and this works through levers to close off the speed governor valve partway.

This closing action is opposed by three forces: The weight of the governor balls; the force exerted by the speed control spring; and the force exerted by the "dashpot." Each of these is important in determining the speed at which the turbine will run. To begin with, without the spring in place, each given speed of the governor shaft will cause the balls to move upward a given distance — the distance increasing with each increase in speed. Therefore, each speed will result in a given valve opening and a given fuel flow.

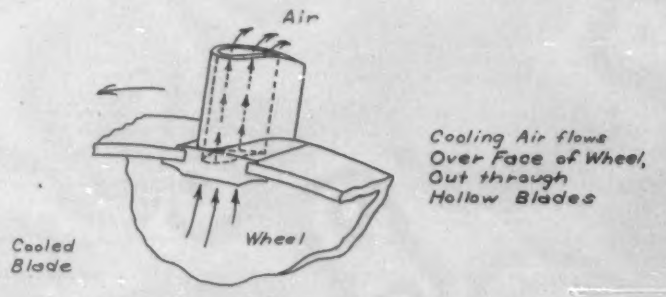


Fig. 15

the creep characteristics. There seems to be a better chance of getting an optimum blade material by improving creep resistance than by improving the heat conductivity.

In axial flow turbines and many centripetal units, stationary blades or *vanes* are used to direct the hot gas into the moving wheel at the best angle for power recovery. Where the turbine uses several stages or rows of moving blades, it also requires a corresponding number of rows of stationary blades. At the turbine inlet, where the gas is hottest, it is often important to cool these stationary blades as well as the moving ones; otherwise, they may have to be made of the very expensive metals needed in the moving blades.

This problem was faced by the Germans when they built their Junkers 004-B1 jet engine. They solved it, though they had rather poor metallurgy at the time, by blowing cooling air inward through the stationary blades and discharging this air level with the roots of the moving blades (Fig. 16). They also cooled the moving blades internally with outward-flowing air. To accomplish this, air was spun outward over the face of the turbine wheel and trapped by a flange around the wheel rim; this flange forced the air through the hollow turbine blades.

Of the many ideas tried to cool turbine blades, the Junkers idea was the simplest and possibly the best to date. A lot of engineers have been trying to improve on it with cored cast blades, drilled-passage blades, liquid cooled blades, etc., but have succeeded mostly in increasing the cost and complexity rather than the effectiveness of cooling.

Effective blade and vane cooling permits the increase of turbine inlet temperatures (within limits) without shortening the life of the turbine. But this life gain is not free. Cooling air is paid for, since you must burn fuel to compress it. It also boosts the cost of the turbine blades considerably to provide passages for this air. It is obviously better to have blade metals that need no cooling, both from an operating and initial cost standpoint.

Turbine Losses

What are the implications when a turbine is inefficient? Gas enters the turbine at a high energy level, but this energy is both thermal energy and kinetic (motion) energy. The purpose of the turbine is to convert as much of this energy as possible into a twist of the turbine shaft. An inefficient turbine lets some of this energy get by it into the exhaust.

An inevitable energy loss in any gas turbine is the *leaving loss.* The leaving loss is the energy required to move the large volume of gas out of the turbine so that more gas can expand into the space it occupied. It may sound insignificant, but its magnitude may be appreciated by visualizing a large fan that moves a corresponding amount of gas. This fan

would require a great deal of power, and this power would compare closely with the leaving loss of the turbine. Since no such fan is used, it can be shown that the gas is moved to the atmosphere by a pressure *higher* than atmospheric pressure at the downstream side of the last turbine stage.

Two things should be said about the leaving loss before moving on: A long and/or small-diameter and/or crooked exhaust pipe will increase the leaving loss because it will take more pressure at the last turbine stage to push the gas through to the atmosphere. Finally, putting a regenerator (refer back to Fig. 10) in the exhaust pipe will increase the leaving loss because it will take more pressure at the last turbine stage to push the gas through the ductwork and heat exchanger. Any increase in the pressure at the turbine outlet will decrease the amount of work it can get out of a gas entering at a given pressure because the work to be had is dependent on the pressure *drop* — not the inlet pressure alone.

One of the toughest losses to stop is the *leakage loss*. In nearly all cases this loss is due to the hot gas squirting through the free space at the tips of moving blades and the stationary vanes. Since the gas expands directly to the outlet pressure without doing any work, its temperature at the lower pressure will be much higher than that of gas that had to work its way through the moving blades.

Why not seal the blade tips? One of the difficulties with this scheme is that the turbine wheel diameter varies with the temperature of the blades, the elastic stretching of the blades due to centrifugal force, and the inelastic "creep" as the blades grow older. Despite the difficulty, however, blades are sealed in a number of ways to minimize tip leakage. The blade tips can be fitted to a common ring or *shroud* (Fig. 17), which in turn is fitted with one or more sealing strips to seal against the case. Another technique is to provide very thin sections at the blade tips (Fig. 18) so that the tips can wear away safely against the case as the blades expand. The stationary vanes are usually fitted with a sealing gland where they meet the turbine shaft between the rows of moving blades to stop leakage along the shaft.

Heating losses in a turbine also show up as an exhaust that is hotter than it should be. Heating is caused by a turbulence in the gas, which can be the result of scouring the gas across the face of the turbine wheel, of forcing the gas through improperly designed flow channels, or of operating the turbine at an off-design speed. The latter causes much agitation of the gas because the moving gas and moving blades no longer "mesh" properly. The moving gas is not where it should be with respect to the moving blade, so turbulent partial-vacuums and pressure pockets occur. These produce a lot of random gas motions that were not planned.

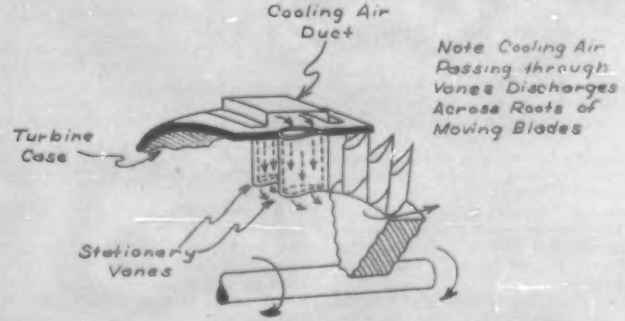

Cooling Air Duct
Note Cooling Air Passing through Vanes Discharges Across Roots of Moving Blades
Turbine Case
Stationary Vanes

Fig. 16

fold along this line—outside edges toward you

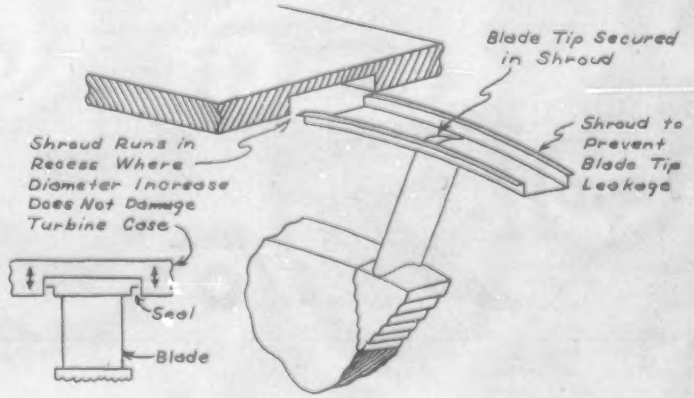

Blade Tip Secured in Shroud
Shroud to Prevent Blade Tip Leakage
Shroud Runs in Recess Where Diameter Increase Does Not Damage Turbine Case
Seal
Blade

Fig. 17

Heating can also result from simple friction of the gas passing over the turbine blades, vanes and other internal surfaces. Whatever the source, the result is the same; the exhaust turns up hotter than it should be.

From the preceding discussion it can be seen that the turbine's loss is the exhaust's gain. Some of the heat of the exhaust can be recovered by good regeneration, but the turbine wheel, regenerator, compressor, etc. must all be larger to compensate for the turbine losses.

Turbine Accessories

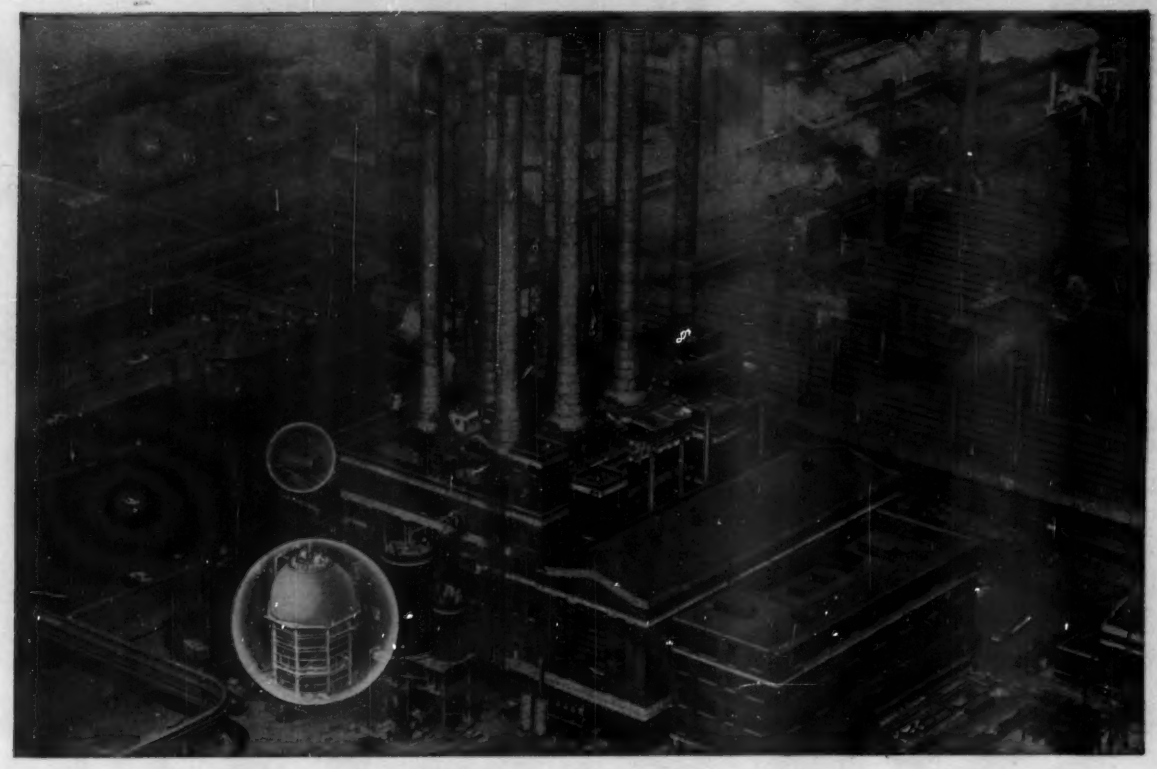
After this much discussion, it must surely seem that we have a complete, functioning gas turbine. But it has no starter, ignition system, lubrication system, fuel system, speed control system, or any means of preventing overtemperature at the turbine inlet. These systems and components come under the general heading of accessories. The term can also cover the gear box needed to take mechanical power from the turbine shaft and deliver it to the various mechanical components.

Starting can be accomplished by any system that will cause the turbine shaft to rotate fast enough. The possible systems include a straightforward cranking motor or engine (Fig. 19) connected through a clutch to the shaft; a motor-generator which can act either as a cranking motor or generator; and finally a compressed air supply which can be released through the turbine wheel to give it that initial spin.

Fuel is usually ignited by a spark plug and the commonplace electrical power supply. It is also possible to ignite fuel with a strong oxidizer (such as white fuming nitric acid) which is injected along with the fuel. This self-igniting mixture is called a *hypergolic* fuel. The latter arrangement has been used almost entirely in aircraft installations, though even those installations find the electrical system more manageable.

As the engine is brought up to a point near its self-sustaining speed, the fuel pressure and oil pressure come up with it since the pumps are (usually) direct-connected. The fuel is admitted to the combustion chamber and the igniters are started. With encouragement like this, of course, the fuel ignites and produces a little push on the turbine. For a while the crank is still engaged, but the load on it is steadily decreasing. The turbine wheel accelerates up to a speed where it can go it alone, and the cranking system is shut down. The igniters shut off immediately after the flame becomes self-sustaining.

The distinguishing characteristic of



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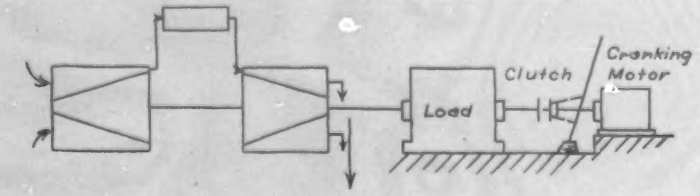
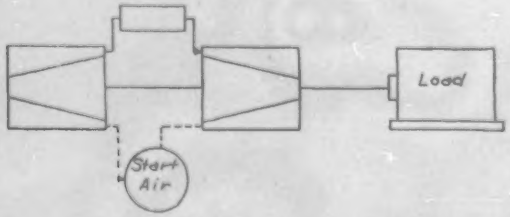
To increase the speed at which the turbine will level off and operate steadily, we can tighten up the speed control spring and increase the force opposing the closing action of the valve. The turbine, then, must rotate faster to close the valve enough to stop acceleration. To reduce the operating speed, we can loosen the spring so that acceleration will stop at a lower speed.

If the system were left like this, the turbine speed would vary up and down continuously. Sudden application of a load, for example, would cause a loss of speed, which would cause the balls to drop, which would cause the fuel valve to open wide. The extra fuel would cause the turbine to speed up again and probably exceed the desired speed, which would cause the valve to close off again — etc. This up-and-down speed fluctuation is called *hunting*. Hunting is offset by some sort of damping device (in our case we use a *dashpot*) to slow down the reaction of the governing mechanism to speed changes.



Starting with clutch-engaged motor



Starting with compressed air

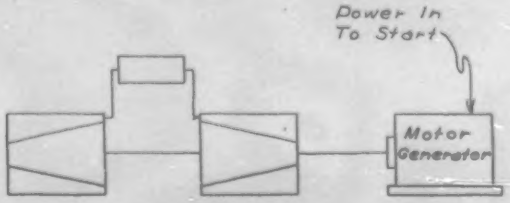


Fig. 19

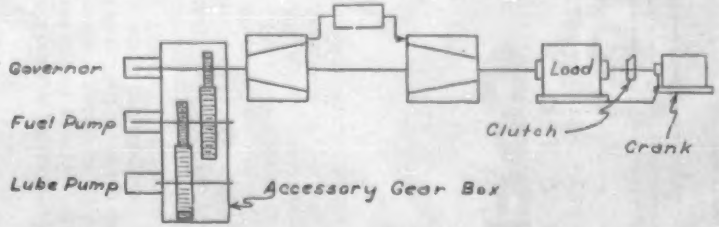


Fig. 20

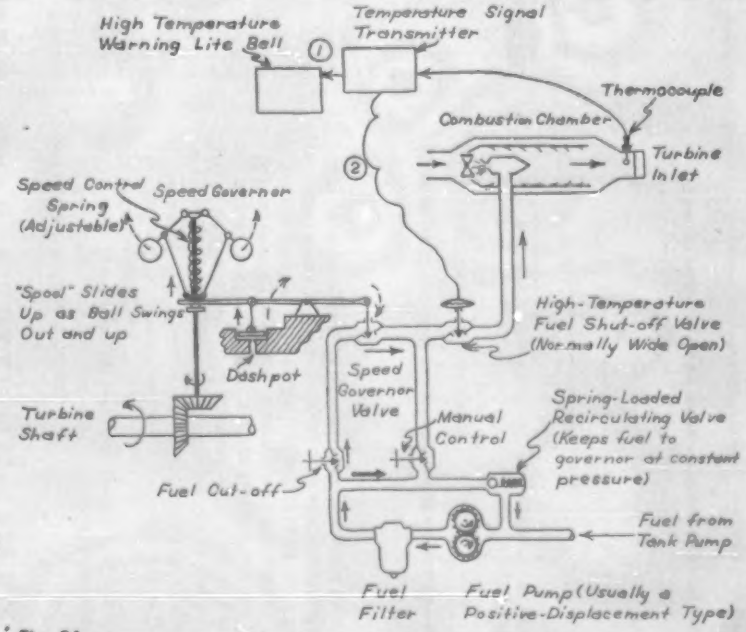


Fig. 21

fold along this line—outside edges toward you

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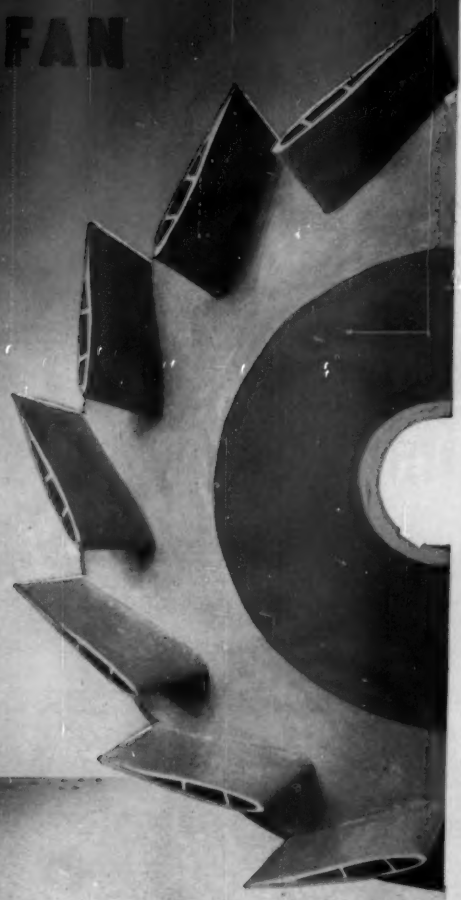

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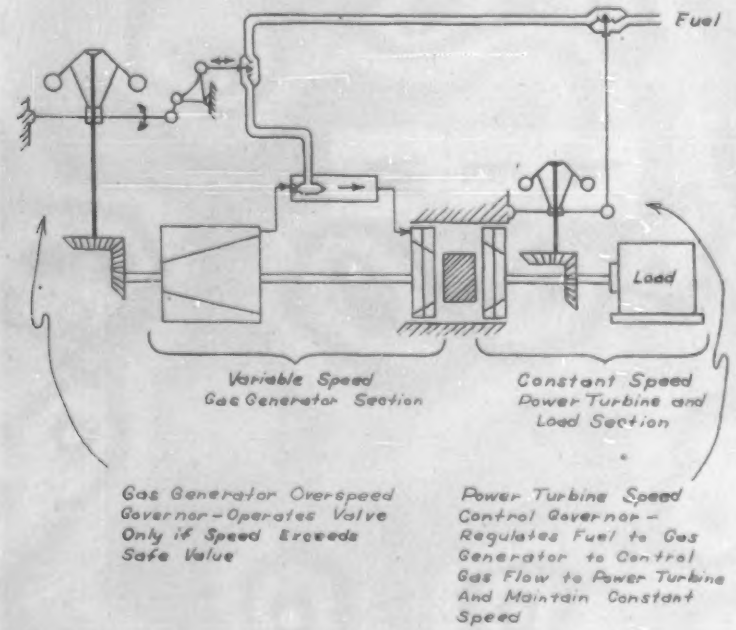

Fig. 22

In studying Fig. 21 you will note that a spring-loaded recirculating valve is in a position to return all unused fuel back to the fuel pump inlet. When all the valves are closed, the fuel is all returned in this manner; otherwise it would rupture the fuel lines before the turbine stopped rotating. When part of the fuel is used, the balance recirculates. It is inefficient to pump fuel this way, but little power is required even then. Furthermore, the spring provides a fairly constant fuel pressure to simplify construction and operation of the fuel control.

As is true of most engineering devices, there are as many ways of employing these principles of control as there are manufacturers. They all accomplish the same general thing, however, and that is speed control under varying loads, minimum hunting, warning of high temperatures, and shut-down if the warning is ignored.

Two-Turbine Machines

Where a gas turbine is to drive a variable load at constant speed, it will be found that the efficiency suffers quite a bit. Turbines and compressors are very sensitive to changes in either flow or speed; also, the common types of compressors must operate at a variable speed to compress a variable quantity of air. To further confuse things, a turbine connected to a varying load requires a varying amount of air to keep the inlet temperatures near constant as the fuel burned changes.

As a result of these conflicting requirements, some manufacturers have advocated (and built) turbines with a gas generator section (compressor, combustion chamber and one turbine wheel) and a power take-off section (a second turbine wheel and sometimes a gear speed reducer). The second turbine operates on its own shaft (see Fig. 22) and can operate at a different speed from the first. As the load increases, the power turbine needs more hot gas and a higher inlet pressure if it is to hold constant speed; so the gas generator turbine and its attached compressor speed up to compress more air. More fuel is burned, but the temperature remains safe because of the corresponding increase in the air it has to heat. The power turbine gets its extra gas supply and holds the load steady.

Another problem comes up at this point, though. What happens if the load on the power turbine suddenly drops to zero? This could happen if it were connected to a generator and the circuit breaker between the generator and the electrical load suddenly opened. Even if the fuel supply were cut immediately, the large gas supply between the two wheels and between the gas generator turbine and combustion chambers would be enough to cause serious overspeeding of the power turbine. So another device is needed to prevent it.

It is common practice to install a pressure relief valve in the ducts between the two turbine wheels (Fig. 23). If the turbine suddenly exceeds the desired speed, this valve opens quickly to bleed the excess gas off to atmosphere. In some cases this same device is placed ahead of the gas generator turbine wheel, but is certainly less necessary there. The gas generator turbine is still connected to the compressor which provides enough load to impede its runaway tendencies.

Variable Speed Output

Recent work in automotive gas turbines has led to the exact opposite conditions to those just described. In the case of automotive units, the power turbine must have an extremely variable speed range — but the compressor must be held above a characteristic speed if its operation is to be stable or even passably efficient. Also, when the automobile (and power turbine) is at rest, the gas generator must be speeded up to develop high torque (twist on the shaft) in the

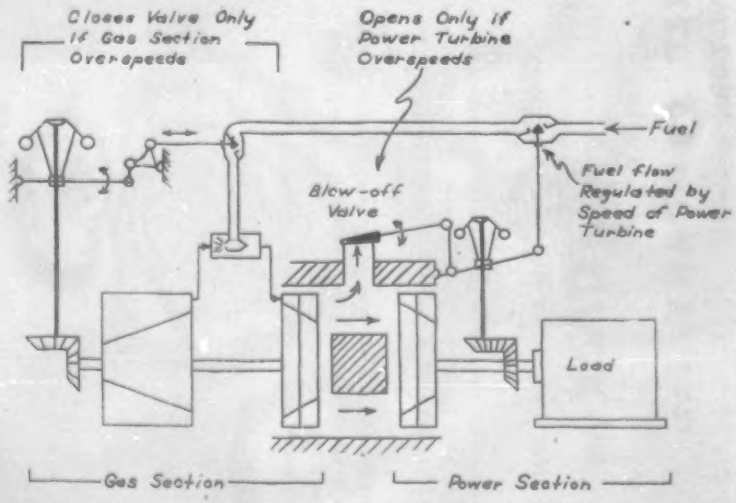

Fig. 23

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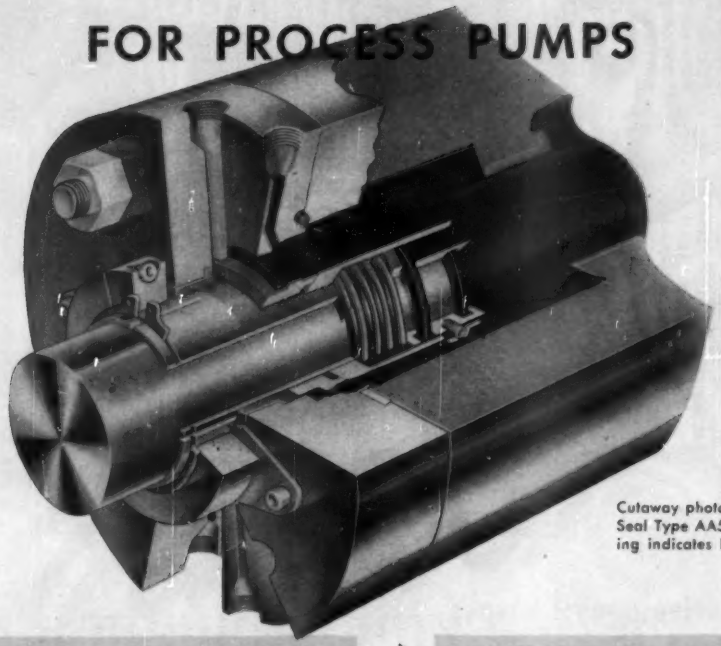

Cutaway photo of Garlock Unitary Seal Type AA51B-23. Yellow shading indicates liquid being sealed.

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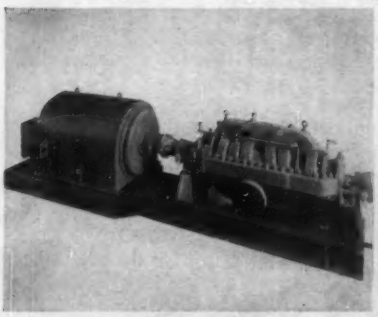
- Maintenance-free life



Typical boiler feed pump for which Garlock Unitary Seals are designed.

SAVE installation time, eliminate maintenance costs with Garlock's new Unitary Mechanipak Seals for process pumps!

The entire unit, including sleeve and gland, is furnished completely assembled. The seal is pre-set at the factory—no on-the-job adjustments are needed. The *external* lock and drive is readily accessible—eliminates set-screw drive.

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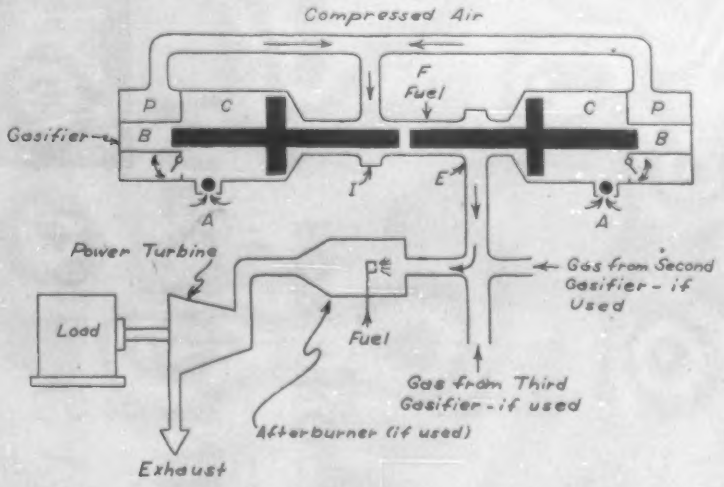

Arrangement of free piston gas turbine with provisions for multiple gasifier units and afterburning.

Fig. 24

power turbine for fast get-away. The separate-shaft or two-turbine machines produce torque characteristics similar to the numerous hydraulic transmissions in use today and will probably make them unnecessary. In this connection, it is also possible that the power turbine will actually consist of two counter-rotating turbine wheels for high torque at low speeds and will have a provision for stopping one wheel to act as stationary vanes when the auto and turbine gain speed.

Free-Piston Turbines

Since we just examined the concept of twin-shaft machines, it should not be difficult to visualize their first cousins called *free piston gas turbines* (Fig. 24). These, too, consist of a gas generator section (*gasifier*) and a power turbine. The difference is considerable, however, for the free piston gasifier consists of reciprocating pistons inside a cylinder where the air is compressed, the fuel is burned, and the power for compressing the air is developed. It is very similar to a typical diesel engine except that it has no crank and it exhausts its burnt gases at considerably above atmospheric pressure. This high-pressure exhaust expands through the power turbine to produce the effective power output.

Gases exhausting from the gasifier are considerably cooler than those entering the first turbine stage of a conventional gas turbine because the work needed to compress the air has already been removed. The cooler gases (900–1000 F) mean that existing materials — even those used in steam turbines — are entirely suitable for the gas turbine wheel without cooling.

Another benefit afforded by this cycle is less direct but very important. A very inexpensive fuel that is quite abundant is "Bunker C" — an extremely variable fuel oil that has undergone a minimum of refining. It has one big draw-back; it is usually carrying a compound of vanadium as an impurity that eats blades away badly. It is dangerous only above 1100 F, however, and the free piston units introduce it to the turbine wheel at least 100 F below this figure. Thus, the free piston turbine can utilize cheaper, abundant fuels.

Remember the simple cycle turbine discussed early in this primer? It did not recover the heat wasted in its exhaust and the cycle efficiency was dependent largely on high compression ratios. The free piston units are very similar in both respects, but they are much better suited to attaining these high compression ratios. Remember the similarity between the gasifier section and the diesel engine — and the diesel commonly works at very high compression ratios. Some units are reported to have over-all efficiencies exceeding 40 per cent, but a figure of 35–38 per cent is more likely to be obtained practically.

One common misconception about the "free piston" gas turbine is that the pistons are free. It is easy to see where such an idea originated, but the pistons are actually linked to one another through various ingenious linkages. This linkage insures that the two pistons will move in opposite directions a proportional distance and at the same time.

The free piston cycle shown in Fig. 24 can be summarized very briefly as follows:

Starting with the fuel injection (assuming a diesel cycle) at F, we have ignition followed by an outward motion of the two pistons. This power stroke compresses air in the two compression cylinders (C) and forces it through valves into the plenum chambers (P). The outward travel of the piston assemblies compresses air trapped in the bounce cylinders (B) and uncovers the air inlet ports (I) and the exhaust ports (E). The exhaust gases expand into the manifold, from which they enter the turbine. Compressed air entering at I forces most of the remaining burnt gas out E. At this point, the air trapped in the bounce cylinders (B) overcomes the inertia of the pistons and forces them back together, drawing more air into C through the valves (A). The cycle repeats.

Two more points should be mentioned about these units before passing on: Several gasifier units can serve one turbine, increasing its reliability. Also, it is possible to burn additional fuel between the gasifier and the turbine (call it *afterburning*) to increase the turbine output. This might improve efficiency as well.

Afterburning (between the gasifier and turbine) will mean that the turbine blades will operate much hotter and that the turbine exhaust will be hotter. It is possible that the exhaust will be *enough* hotter to permit using it to heat the gasifier exhaust. Certainly, however, the amount of heat recovered from the exhaust gases will be less than in the conventional cycles because the gasifier exhaust has already been heated.

The next issue of POWER ENGINEERING Handbook will contain Part III of the Gas Turbine Primer. This section will be devoted to unusual or specialized cycles and gas turbine applications, with a special emphasis on the recovery of exhaust heat.

Maintenance Ideas are Worth Money

You should share your ideas for the maintenance of power equipment, and the sharing can be made quite profitable. POWER ENGINEERING Handbook can use practical ideas that have been tried and proven, especially if they are accompanied by an explanatory sketch or photographs. Drawings need not be professional, nor the writing fancy, but the ideas should be your very best. We will pay for them on acceptance, though it may be some time before the space is available to print them. Keep the Handbook of maximum usefulness. Well-trained operators and maintenance men benefit the entire power industry.

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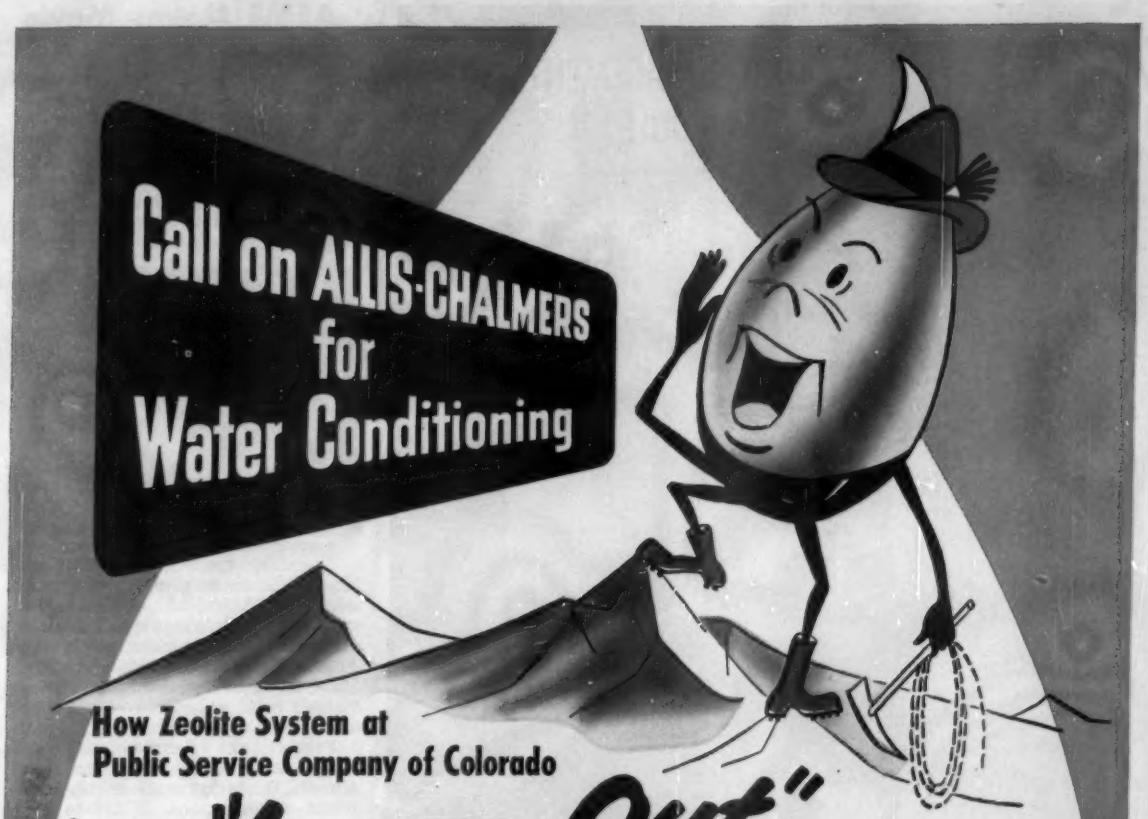

How Zeolite System at Public Service Company of Colorado

"Irons Out"

Water Irregularities Caused by Fluctuating Loads

DENVER'S UNUSUAL CLIMATE causes unusual water conditioning problems at Public Service Company of Colorado's Zuni Station. Steam from this station is used to heat downtown Denver buildings. Denver's balmy midday climate — except in the two cold months of the year—is the cause of troublesome load fluctuations.

The lime-soda-phosphate system installed in this plant by Allis-Chalmers in 1949 was one of the most modern in the country at the time. It is ideal for extremely high loads in the morning and evening, but requires careful adjustment to handle the low loads around noon.

Public Service of Colorado has decided to modernize to take advantage of developments in "hot lime-hot zeolite" systems since the original installation. The zeolite part of the system acts as its own corrective when loads drop, "ironing out" hardness irregularities in the lime effluent and eliminating need for manual adjustments. The new system will provide more consistent operation and lower hardness. The only chemicals needed are lime and salt, holding operating costs to a minimum.

The changeover, being handled completely by Allis-Chalmers, consists of adding zeolite softeners to the original equipment furnished by A-C.

Next time you have a water problem — or want to consider modernization — take advantage of Allis-Chalmers water conditioning experience. For information, call the A-C office nearest you or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

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ASME Makes Movie

TO HIGHLIGHT its 75th Anniversary, the American Society of Mechanical Engineers has sponsored a 25-minute color motion picture for showing to the general public. Entitled, "To Enrich Mankind," the movie is designed to make clear to the man-on-the-street the function and importance of the engineer in our society.

The story opens in the "National Museum" where a crusty old caretaker regards models of elementary machines with skeptical boredom. Stirred by this cynicism, a statue of Archimedes comes to life and shows old Gus how engineers have transformed basic principles into a more abundant way of life.

Prints of the 16-mm color film are available on loan, without charge, to schools, television stations, and nonprofit organizations. Write to Barbara A. Brown, Public Relations Dept., ASME, 29 West 39th St., New York 18, N. Y.

Companies Combine Efforts in New Station

NEW $4,500,000 PRESQUE ISLE Station which has just been placed in operation for the Upper Peninsula Generating Co., a non-profit operating company formed by two concerns in need of power and now able to obtain it on a less costly basis by combining their generating efforts, will produce 22,000 kw for the expanding industrial needs of Michigan's upper peninsula.

Stone & Webster Engineering Corp. was retained separately in 1952, by Upper Peninsula Power Co., an independent utility, and The Cliffs Power & Light Co., a subsidiary of The Cleveland-Cliffs Iron Co. Each company was in need of greater generating capacity and both initiated construction programs to be undertaken by Stone & Webster.

The Upper Peninsula Power Co. proposed to install a 7,500 kw turbine generating unit and associated facilities at Houghton, Michigan, while The Cliffs Power & Light Co. was prepared to install 11,500 kw of capacity as an extension of their station at Ishpeming.

Both companies, working with Stone & Webster, soon realized the advantages of interconnecting their

systems and jointly constructing a larger, single power plant which would be less costly to build and operate and would furnish more reliable service to both companies for their respective consumers at the lowest possible cost.

Stone & Webster made studies of all aspects of the proposed operation and obtained specific data on savings to be effected by joint investment in generating facilities and transmission lines. The Cliffs Power & Light Co. was then dissolved, and the Upper Peninsula Power Co. and The Cleveland-Cliffs Iron Co. settled upon the construction by Stone & Webster of a steam power plant to be owned jointly by them and operated on a non-profit basis by the newly incorporated Upper Peninsula Generating Co.

The new steam power station was constructed on Lake Superior at Marquette, Michigan, with the initial installation consisting of a 22,000-kw preferred standard turbine generator and a 220,000-lb-per-hr steam generating unit, operating at 850 psi and 900 F, arranged for coal firing. Power leaves the step-up substation at 69 kv and is delivered to both the iron company and the power company. The two networks are connected by a 100-mile transmission line. Coal is brought to the power plant by rail from the Marquette coal dock and unloaded from a 600-foot trestle in the coal storage area.

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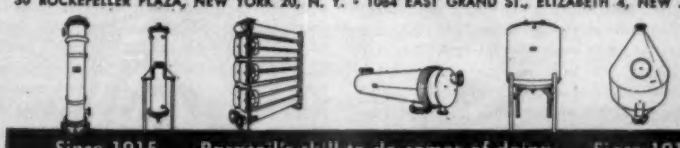

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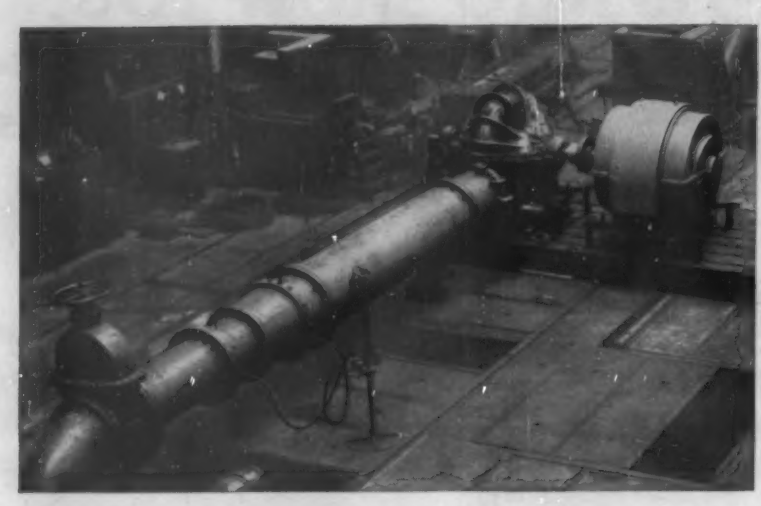


We have a lot of experience at Worthington—more than 114 years of it—and we're picking up more all the time.

But technology advances every day. Each step forward brings with it new and unsolved pumping problems. That's why Worthington's research and development program is continuous. That's also why we like to work with you during planning to get the jump on problems before they reach the costly stage.

Experts for every problem

For your day-to-day pumping problems, our sales engineers are thoroughly trained in pump applications in every field, and can usually supply the right answer fast. Naturally, for the really tough ones, our staff engineers back them up with all the equipment and facilities of our shops and laboratory. In addition, factory-trained troubleshooters are available to cope with any problem that may arise in the field.

From cat-cracker to atom-cracker

Our specialists, covering all major industries, work as a team. Together, they bring to bear on any problem a vast store of experience. They've successfully solved pumping problems and helped pioneer new developments in public works, atomic energy applications, the oil industry, and the chemical industry—to name a few.

So keep your eye on Worthington; we probably have a money-saving answer to your pumping problems. C-5.1

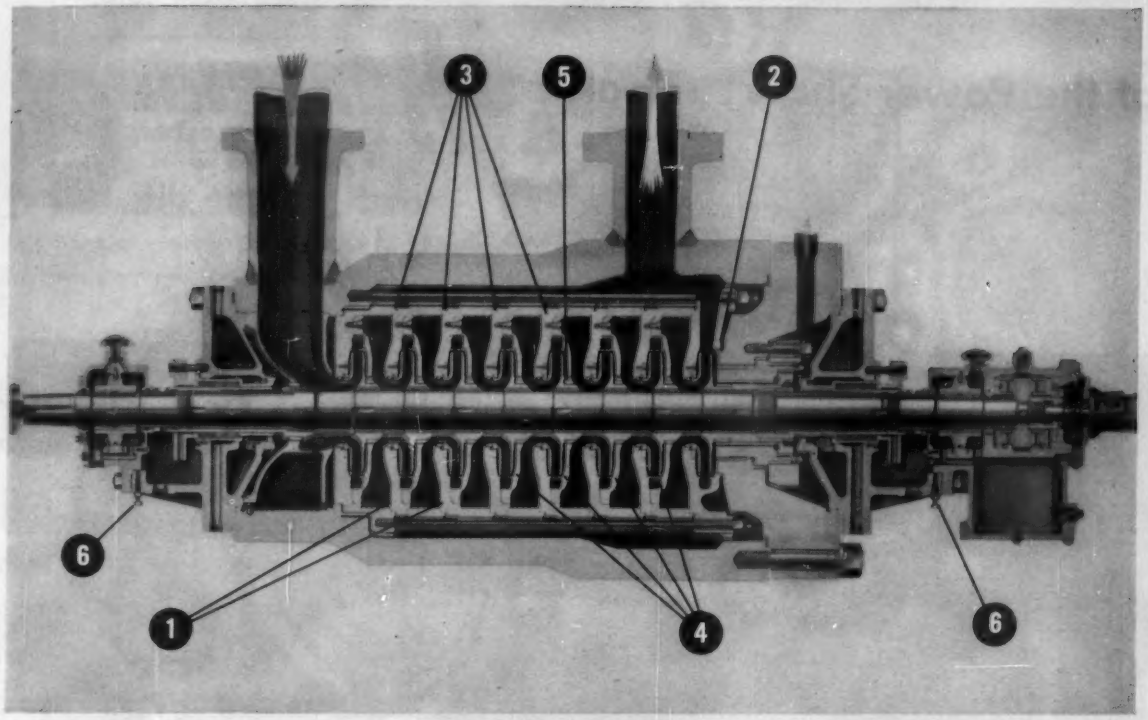
TEST STAND CAPACITY UP TO 100,000 GPM is provided at Worthington's Harrison plant *(above)*. Built over a man-made half-acre lake, the test stand is used as a production tool to check pumps from fractional horsepower up. This flexibility comes in handy—in one line alone Worthington can put together 60,000 different standard pumps out of 650 parts in six standardized sets of liquid ends.

DIRECTING PUMP TEST OPERATIONS from central control room *(left)* where special measuring instruments speed collection of performance data. Worthington pump specialists can afford to be objective in considering your pump application problem. They select from the most complete line of pumps offered by any manufacturer.

WORLD'S FIRST ATOMIC-POWERED SUBMARINE, *NAUTILUS*, undergoing sea trials. In atomic development since 1941, Worthington recently built special engine room equipment for both atomic submarines, *Nautilus* and *Sea Wolf*. Worthington continues to figure prominently in supplying this new field of atomic energy, keeping pace with its new and rapidly changing requirements.

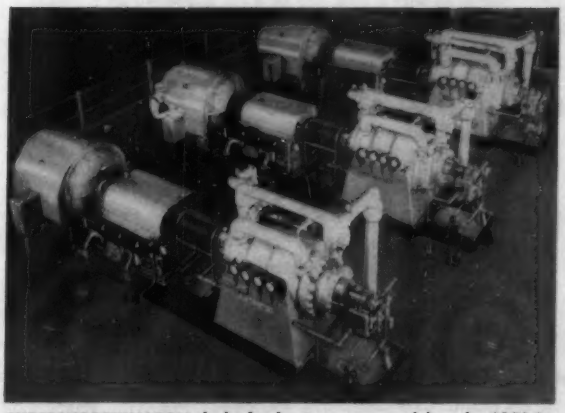
EUTECTIC CASTING, used in making standard Worthington pumps, frees engineer from casting restrictions. Formerly, design of impeller and diffuser blades had to allow hand withdrawal from fragile sand core. Eutectic casting uses a low-melting-point alloy to form blades, melting this alloy out during baking. This permits design flexibility for maximum hydraulic performance.

VITALITY OF WORTHINGTON RESEARCH PROGRAM is shown by the more than 300 articles in the technical press during the past five years by Worthington people. This flood of informative technical literature not only reflects our ability to keep pace with the changing hydraulic requirements for modern pumps, but also highlights the important contributions by Worthington to the knowledge of pumps.



WORTHINGTON high-pressure (over 1300 psi) boiler feed pump in cutaway view. Intake at left, discharge at right. Green areas show feed water path.

Look inside a Worthington high-pressure boiler feed pump



THREE WORTHINGTON six-inch, six-stage pumps, driven by 1250-hp motors through hydraulic couplings, feed boilers at Benning Station of Potomac Electric Power Company and help to provide power and light to homes and industry in the District of Columbia and portions of Maryland and Virginia.

They don't show on the outside, but here are seven basic features that are standard on Worthington high-pressure boiler feed pumps. They've been proved and improved over the 32 years since we pioneered the first high pressure centrifugal boiler feed pump. (Numbers are keyed to cutaway above):

1. **ALL PRESSURE JOINTS** are metal-to-metal ring-type joints, the best construction for high-pressure service.
2. **INNER ASSEMBLY** firmly anchored at inboard end but free to expand with temperature changes and slide over centering fit in discharge head at outboard end.
3. **HYDRAULIC PRESSURE** acts to seal internal joints rather than open them.
4. **TWIN-VOLUTE** casing design has better hydraulic characteristics than common multiple vane diffusers while still eliminating radial thrust.
5. **ALL IMPELLERS** are shrunk on and keyed to shaft.
6. **VERNIER JACKSCREWS** at each end facilitate final adjustment of bearing centers.

Get the whole story on these high-pressure boiler feed pumps. Write for Bulletin W-319-B1D. Worthington Corporation, Harrison, New Jersey. C-5.1B

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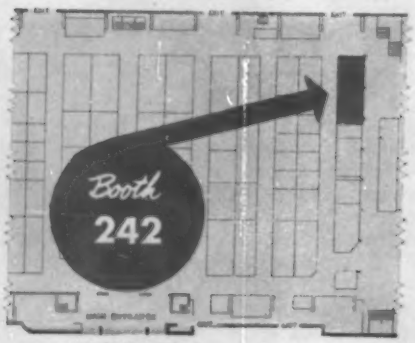

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WATER CONDITIONING

201 What's What on Ion Exchangers — Here are three booklets on ion exchangers: Nalcite HCR, a styrene type cation exchanger; Nalcite SAR, a strongly basic anion exchanger; and Super Nalcolite, a synthetic gel type zeolite for cation exchange. Tables and graphs explain performance of these water treating resins under various operating conditions. Physical characteristics, exchange capacities, regeneration techniques discussed. Bulletin 57, 20 pp, is on Nalcite SAR; Bulletin 58, 28 pp, Nalcite HCR; Bulletin 59, Super Nalcolite. National Aluminate Corp.

202 Handbook on Demineralizing — Comprehensive 40-pp Bulletin 5800-B compares various methods of water treatment, indicating the comparison between demineralizers and evaporators. It discusses the characteristics of the various types of available cation and anion exchange materials and offers data on operating costs of demineralizing. It tells when to use 2-bed, 3-bed, 4-bed, mixed or monobed demineralizers. It also indicates when decarbonators or vacuum deaerators should be installed. Cochrane Corp.

203 Modern pH and Chlorine Control — This 100-pp booklet gives details on color comparators and equipment in water testing and control of boiler and industrial process water, also technical information on meaning of pH control, electrometric and colorimetric methods of determining pH and impurities in water; applications of water control in air conditioning; feedwater. W. A. Taylor & Co.

It's easy to get these free catalogs — just circle item numbers of those wanted on the postcard at right.

204 Water Conditioning Data Book — An excellent reference volume, Data Book 2478A contains 108 pp and presents a compilation of 78 chapters and tables. Subjects covered include hydraulics; impurities in water; chemical conversions; coagulant, acid and alkali dosages; chemicals used in water treatment; water treatment processes; boiler feed make-up requirements; alkalinity relationships; specific gravities; chemical reactions. Available to qualified power engineers, please state your job title when requesting this. The Permutit Co.

205 Feedwater Treating — Bulletin 1855, 30 pp features manufacturer's hot process Accelerator for treatment of boiler feedwater, illustrating and explaining its operation and advantages, also optional

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equipment. Contains excellent discussion of necessity for treatment of makeup water, selection of proper equipment. Also covers the limitations of hot process softening. Infilco Inc.

206 Water Treatment — Bulletin 5000, 24 pp, explains the reasons for boiler water treatment and tells services offered by company in providing formulations for individual plant requirements. Covers pretreatment, internal treatment, treatment application, blow-down adjustment, test control. Dearborn Chemical Co.

207 Demineralizers — Valuable information on demineralization is offered power engineers in comprehensive 24-pp Bulletin WC-111. Discusses demineralization in general and its advantages and applications. Basic types of demineralizers and their special uses are charted. Resins, piping, valves and accessory equipment are treated in detail. Book also provides flow charts showing demineralization systems for chemical plants and power plants. Graver Water Conditioning Co.

208 Microbiological Control — Technical Article 3C, 12 pp, is an illustrated discussion of microbiological control of and through industrial waters. A section on industrial water chlorination covers cooling waters and process waters. Other sections deal with chlorine metering in chemical processes, and the sanitary aspects of industrial water treatment. Wallace & Tiernan Co., Inc.

VALVES, TRAPS, PIPING AND ACCESSORIES

209 Check Valves — Twenty-pp Catalog 30 presents company's line of tilting-disc check valves made in iron, bronze and steel for working pressures to 3000 psi. Explains operating principles of tilting disc construction, discusses closing without slam, reduced loss of head, other advantages. Includes construction details, sizes. The Chapman Valve Mfg. Co.

210 Lubricated Plug Valves — Revised Catalog PV-2, 12 pp, presents steel and semi-steel valves designed to offer quick shut-off of erosive or corrosive fluids. Explains advantages of the lubricated tapered plug design of these valves and pictures single gland, screwed gland, and bolted gland types. Also shows accessories. The William Powell Co.

211 Blow-Off Valves — Bulletin B-426, 20 pp, on blow-off valves for boiler pressures up to 400 lb wsp, contains installation recommendations, construction information on Yarway seatless and double-tightening blow-off valves. Gives full ordering data. Yarnall-Waring Co.

212 For Precise Control — Fifty-pp Catalog 17 covers manufacturer's line of disc valves and accessories, providing full selection and ordering data, materials of construction, sizes. Describes manual and automatic controls for these valves which, it is noted, are available in any metal which can be cast or welded. Minimum pressure drop, quick closure, simplicity and other advantages are discussed. R. S. Valve Div., S. Morgan Smith Co.

213 Choosing the Right Valve — Presenting valve selection as a matter of matching the valve's service characteristics with service requirements of the job, this practical 20-pp booklet explains and illustrates basic design features of

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214 Valve Chart — Form 194, 24 pp, is a valve comparison chart, listing valve figure numbers of 15 major manufacturers and the OIC equivalent valve figure numbers. Compares variety of valves in ferrous and non-ferrous materials, describes different valve lines. The Ohio Injector Co.

215 Steel Gate Valves — Four types of Hancock general purpose steel gate valves for process and power piping systems are described in illustrated Bulletin 202 C, 12 pp. Material specifications, dimensions given, also service pressure ratings. Manning, Maxwell & Moore, Inc.

216 General Service Valves — Bulletin E-160, 16 pp, describes and illustrates design and construction of company's quick-operating valves, explaining their application to blow-off service and on chemical process, soot blowers, water column blow-down, and other types of pipe line. Everlasting Valve Co.

217 Regulating Valves — Bulletin 5305 describes double seated diaphragm regulating valves for use with control instruments, outlining special features of the valves, particularly the "flow line" contoured-body engineered for high capacity at low pressure drop. Leslie Co.

218 Industrial Valves — Condensed Catalog 105, 28-pp, contains data on valves for a wide variety of applications. Includes dimensions and illustrations describing non-return (stop-check) valves, globe and angle stop valves, pressure seal design, angle univalves and small size globe valves designed for chain or extension operation in vertical lines. Also included is company's Mudwonder valve for abrasive fluids. Edward Valves, Inc.

219 To Get at Those Valves — This little folder describes a sprocket rim with chain guide. The rim adjusts to fit all valve wheels. Babbitt Steam Specialty Co.

220 Steam Trap Book — Catalog J, 44 pp, serves as a manual of trapping practice. Includes a catalog section giving physical data and prices on cast semi-steel and forged steel inverted bucket steam traps, compound steam traps and ball float air and air relief traps; a handbook section explaining how to calculate condensate loads and select traps for all classes of equipment; a maintenance section explaining trap installation, trouble-shooting and repair. Armstrong Machine Works.

221 Steam Trap Solutions — Bulletin F. 151, 36 pp, is a newly revised edition of this company's well known booklet, "Solving Steam Trap Problems." Organized for easy reference, this illustrated booklet provides specifications and capacities of steam and float traps, air release valves, pipe line strainers. Tells how to calculate condensation loads and select traps for unit heaters, jacketed kettles, submerged surfaces. Gives tips on installing, servicing. The V. D. Anderson Co.

222 Insulated Piping Systems — Prefabricated insulated piping units for underground or overhead systems are described and illustrated in this 24-pp booklet. Tells advantages of this insulated piping and gives specific application in-

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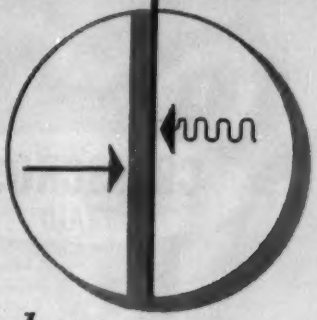

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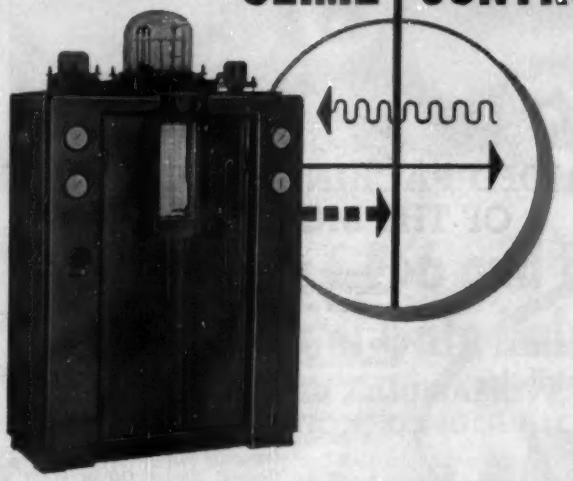

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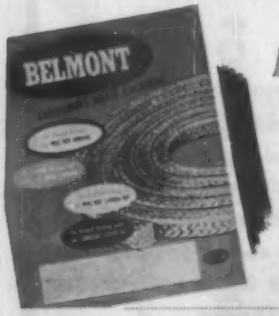

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formation on Uniline insulated units, insulated jacketed pipe units, prefabricated accessories, field connections. Shows features that make these units easier to install and pictures some applications. Specifications and trenching data are included, also conduit sizing chart. Booklet also describes cast iron insulated pipe units, and Utilidor conduits. Ric-wiL, Inc.

223 Improved Pipe Hanger — Twelve-pp Bulletin 153 describes company's Counterpoise pipe hanger for high temperature piping systems in steam generating stations, refineries and chemical plants. Tells how it offers efficient load supporting effort of constant value throughout entire range of travel as pipe expands or contracts. National Valve & Mfg. Co.

224 Unions and Fittings — Twelve-pp Catalog 50 covers manufacturer's line of unions of all types, elbows, tees and fittings. It describes and illustrates special features. Dart Union Co.

225 Expansion Joints — Rubber expansion joints for relieving strains and stresses in piping, absorbing vibration, and eliminating noise are the subject of 8-pp Form AD-137. General advantages of rubber expansion joints are presented, and spool-type U-type and rectangular-type joints are described as to construction and intended services. Also provided is catalog sheet on all-Teflon joints and Teflon-lined rubber joints. The Garlock Packing Co.

ELECTRICAL EQUIPMENT

226 Motor-Generator Reference Book — Publication 51R7933 is a 50-pp booklet compiled to assist in the selection of motive power to handle most industrial applications. Neither textbook nor ordering catalog, this book provides a brief outline of the various types of motors, generators and motor-generator sets, telling their applications and operating requirements. Booklet is generously illustrated and includes performance data, ratings, information on methods of speed control. Allis-Chalmers Mfg. Co.

227 Motor Buying Guide — Bulletin GEC-1026, 28-pp, features company's standard a-c fractional and integral horsepower motors in most general use. Included are general- and definite-purpose fhp motors, and fhp gear motors. A section on selection of integral horsepower motors covers horsepower requirements, enclosures, starting current limitations, speeds, motor types, and selection of fuses and circuit breakers. Descriptions and specifications include single-phase, polyphase, totally enclosed fan cooled, and gear-type integral horsepower motors. Ratings, book prices, dimensions, frame numbers are included. General Electric Co.

228 Electric Motors — Twenty types of company's motors are illustrated in 8-pp Bulletin 1878. Illustrated in natural color, the bulletin contains descriptions of Uni-closed, totally-enclosed, explosion-proof, Varidrive, Syncrogear, combination variable speed and internally geared units, right-angle worm gear, and other types. U. S. Electrical Motors, Inc.

229 Insulation Temperature-Resistance — Technical Publication 21T4, 16 pp, is an article on temperature-resistance characteristics of electrical insulation. Complete with tables and graphs, gives general information on variations in temperature characteristics, composite nature of electrical insulation, and practicability

of temperature compensation. Other chapters deal with determining insulation constants for temperature correction factors, and a practical method of obtaining insulation temperature. James G. Biddle Co.

230 The Answers on Wiring — "20 Questions and 20 Answers on Safety m.i. wiring" describes and illustrates characteristics and advantages of this new wiring system. A complete table of types, sizes, weights and lengths, as well as a partial list of users included. General Cable Corp.

231 High-Power Batteries — Bulletin CP-538/55 covers company's line of Hi-Power batteries for use in the control, switchgear, emergency lighting and auxiliary power fields. Includes data on battery ratings and capacities, details of design and construction, dimensions, weights and types of containers. C & D Batteries, Inc.

PUMPS, COMPRESSORS

232 Boiler Feed Pump — A barrel-type boiler feed pump for high pressure, high temperature service and designed to go on the line quickly without preliminary warm-up is the subject of 12-pp Bulletin 1525. De Laval Steam Turbine Co.

233 On Vertical Pumps — Sixteen-pp Bulletin describes and illustrates application of vertical industrial service pumps for liquid transfer from short settings in both industrial and process services. Points out advantages and describes three basic designs. Stresses versatility of the pumps due to design flexibility. Also gives general recommendations for obtaining optimum performance, and includes photos of typical installations. Peerless Pump Div., Food Machinery and Chemical Corp.

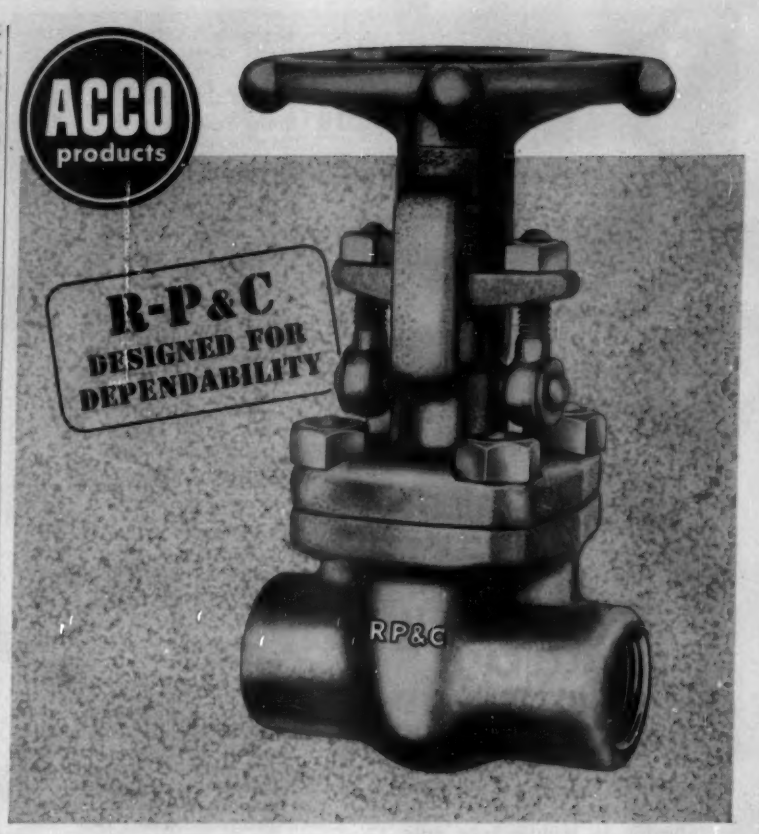
234 Controlled Volume Pumps — Bulletin 953, 24-pp, describes and illustrates use of controlled volume pumps in industrial water treating systems. Construction and operation features are described, capacity-pressure ranges and speed and stroke length adjustments are charted. Typical chemical feed and water treating systems are presented through text and diagrams; and an analysis of boiler water treating systems, cooling water treating problems, and systems for waste and sanitary water treatment included. Milton Roy Co.

235 Boiler Feed Pumps — Bulletin 109, 16 pp, illustrated in color, describes centrifugal pumps for boiler feed service. Pictures construction and major parts, floating seal incorporated. Capacity data included. Pacific Pumps, Inc.

236 Balanced Opposed Compressors — Engineering data on company's balanced opposed compressors, 3000 to 10,000 hp (top range in tandem arrangement) is contained in 36-pp Bulletin L-679-B1. Presents information on operation, drives, design features, running gear, lubrication, valve action, capacity control, coolers and accessories. A chart listing approximate dimensions is included, along with photos of compressor installations. Worthington Corp.

INSTRUMENTS AND CONTROLS

237 Metering and Control Equipment — Sixteen-pp Bulletin 18 is a comprehensive catalog offering information on company's meters, control equipment and engineering services. It is written for engineers in power plants, public utilities



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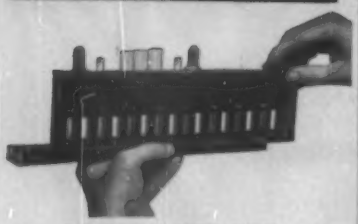

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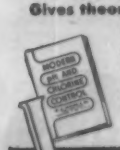

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and process plants. Fifteen measured variables common to power and process operations form the index for selecting appropriate equipment. Bailey Meter Co.

238 Boiler Feed Control — Bulletin 1003, a 12-pp catalog on boiler feed regulators, is illustrated with large application photos and detailed schematic drawings and charts. Relay and direct operation are covered. Case studies of representative boiler loads are presented to show stability of the Flowmatics in controlling feedwater automatically. Copes-Vulcan Div., Continental Foundry & Machine Co.

239 Instruments, Controls — Condensed Catalog 1537 offers brief application information on manufacturer's line of instruments. Fully illustrated, covers draft and pressure instruments, flow meters, liquid levels and pressure gages, CO_2 meters, pneumatic transmitters, positioning operators, temperature instruments, boiler feedwater controls, others. Includes references to detailed literature on each type of equipment. Republic Flow Meters Co.

240 Electronic Flow Meters — Publication 55-1074-222, 12-pp, describes company's line of electronic flow meters for measurement of differential pressures, liquid level, fluid, gas, air or steam flow, temperatures and pressures. Points out advantages, describes mercury-less transmitters, transmission system, receiver, integrator, other features. The Hays Corp.

241 For Feedwater Analysis — Bulletin 148BP contains a technical discussion of manufacturer's analyzers for determination of dissolved oxygen and hydrogen in feedwater. Discusses both O_2 and H units as to function, ranges, accuracy. Cambridge Instrument Co., Inc.

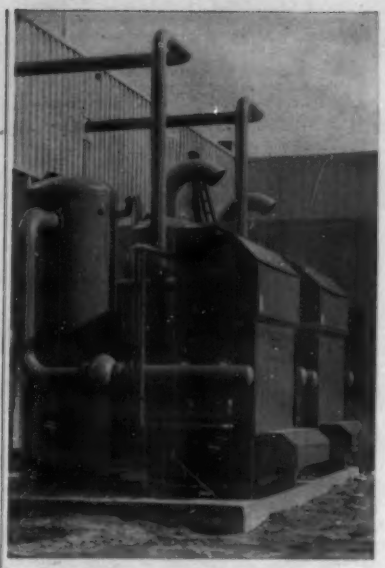
242 Indicating Flow Meter — Bulletin 18-A, 22-pp, discusses advantages, construction and operation of company's Type H indicating flow meter. Presents technical data on the principles and theory of fluid measurement and discusses orifice type meters and orifice meter principles. Offers examples of flow rate calculations. Schematic drawings and diagrams, tabulated technical data and specifications are included. The Meriam Instrument Co.

243 Sampling System — A newly developed system for continuous sampling and oxygen measurement of combustion processes is described in Bulletin 703. Points out advantages of system and diagrams component parts. Selection of sampling tube and gas selector units is discussed. Arnold O. Beckman, Inc.

244 Ideas on Push-Pull Controls — Included in this "Idea File" are answers to a power engineer's questions on the use of push-pull controls. A general information booklet discusses remote control applications, explains construction and operation of company's Tru-Lay controls. Separate bulletins are devoted to standard assemblies, bracket-type head controls, micro controls and hand-operated controls. Automotive and Aircraft Div., American Chain & Cable Co., Inc.

COAL, ASH HANDLING

245 Burning Bituminous Coal — This 24-pp illustrated booklet is a compilation of numerous actual case histories of industrial plants and institutions which burn bituminous coal "the modern way." Stressing operating economy achieved, these case histories show problems over-



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come, equipment used, and savings realized. Bituminous Coal Institute.

246 Why Liquid Diffusion — What liquid diffusion can do for power plants is explained in Form B, which tells how liquid diffusion compounds work and gives four practical applications. These include dust control in coal handling, fly-ash control, coal storage pile treatment and boiler cleaning. Johnson-March Corp.

247 Fly Ash Collection — The successful and economical separation of fly ash from boiler flue gases is discussed in 28-pp Catalog G405. Explains need for collection equipment and gives physical characteristics of fly ash. Describes company's Multiclone equipment as to principle of operation, performance and advantages. Western Precipitation Corp.

248 Spreader Stoker — Sixteen-pp Bulletin 800 describes manufacturer's Type C-C RotoStoker, a relatively small spreader stoker offering continuous cleaning and ash discharge advantages of larger units, without need of a basement for ash-removal. Explains this and other operational advantages of the stoker, which is adapted to modern steam boilers with output capacities of about 5000 to 75,000 lbs of steam per hour. Detroit Stoker Co.

BOILERS, GENERATORS

249 Packaged Boilers — This 16-pp illustrated catalog describes manufacturer's new Type VP package boiler. Following a section of background information is an outline of the principal design features of these boilers, which are shop assembled and provide steam capacities from 4000 to 30,000 lb per hour. Space requirements are shown in a table along with typical specifications. Also described is control system. Combustion Engineering, Inc.

250 Improved Steam Generator — Bulletin 2000, 28 pp, explains advance design features that distinguish this manufacturer's generator from other unit steam generators. Describes and illustrates engineering differences of component features. Also shows how these components are constructed, assembled and tested. Another section gives data, and dimensions for the units which range from 20 to 6000 hp. Preferred Utilities Mfg. Corp.

Postage-free cards for ordering catalogs are on page 118. You may also use the cards to order literature mentioned in the ads.

251 Steam Generators — Illustrated Bulletin SB43, 20 pp, describes company's VL factory assembled generators combining 2-drum water-tube boiler, integral water cooled furnace, brick work, insulation and steel casing. A large cutaway illustration shows design details, and gas travel. Erie City Iron Works.

252 Steam Generator — This manufacturer's new Type D steam generator, a packaged unit for pressure firing with gas, oils or combination of fuels, is described in an 8-pp catalog. Gives complete data and dimensions on this water tube generator which is available in 17 sizes with capacities from 8000 to 40,000 lb of steam per hour. Fully illustrated, booklet

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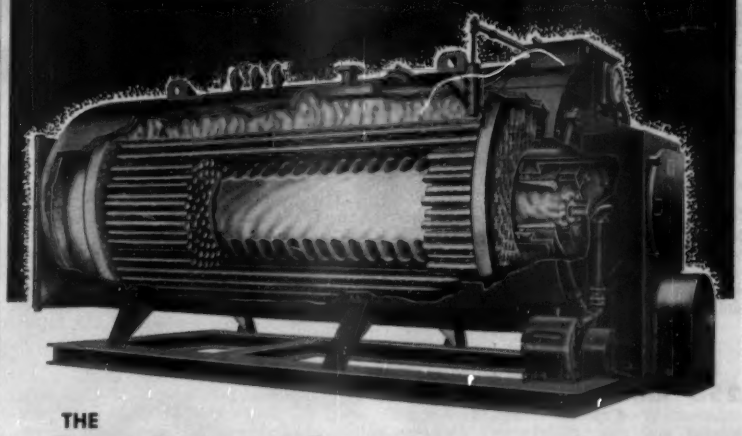

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explains economical steam production. Superior Combustion Industries, Inc.

253 Standard Boilers—Eight-pp Bulletin WT-8 describes company's "S" series of boilers with capacities ranging from 10,800 to 50,000 lb. Lists data and specifications on each of the models and sizes, and discusses general design features and special "S" type construction features. Wm. Bros. Boiler & Mfg. Co.

254 Automatic Boilers — Bulletin BE-4 describes operation and advantages of Continental automatic boiler's spinning gas technique — a method of obtaining maximum heat transfer with a simplified design. Shows cutaway view of boiler construction; illustrates hinged doors and method of injecting air through static, turbine-like vanes into burner. Boiler Engineering & Supply Co., Inc.

255 Self-Contained Boilers — Bulletin AD-144 reviews company's new CB boilers. Illustrations include installations, demonstrations. Engineering articles are featured covering such subjects as low noise level. Cleaver-Brooks Co.

REFRACTORIES

256 Refractory Concrete — Basic information on recommended practice for mixing and placing refractory concrete, used in the metal, power, ceramic, and petroleum refining industry as a material to withstand service temp to 2600 F or more, is presented in this 16-pp manual. Sections are devoted to special properties of refractory concrete, aggregates, refractory insulating concrete, and structural design. Charts and tables afford easy reference. Universal Atlas Cement Co.

257 Refractory Notes — Included in Vol. XV of this company's Thermogram is an illustrated article on a method for decreasing hot topping costs in steel mills with minimum capital expenditure. Another story tells how bonded brick assemblies cut installation time in a coke plant. Refractory & Insulation Corp.

TUBING AND ACCESSORIES

258 Rotary Tube Cleaners — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads. Roto Div., Elliott Co.

259 Nickel Pipe and Tubes — Bulletin T-17 is a 28-pp technical bulletin on the fabrication and design of nickel and high nickel alloy pipe and tubing, illustrated throughout by drawings and photos. Presents tables on mechanical and physical properties, ASME code requirements, recommended welding procedures. The International Nickel Co., Inc.

260 Condenser Tubes — Excellent information on condenser tubes and their service life is given in this 40-pp illustrated booklet. Subjects discussed include corrosion of condenser and heat exchanger tubes, corrosion resistance and control, the selection of tube materials, and the composition and physical properties of company's alloys. Gives details on proper installation. Scovill Mfg. Co.

261 Life Extension for Condenser Tubes — The 32-pp current edition of this booklet reports on research into the causes of corrosion and means of combating them, as well as the choice of condenser tube materials. Points out that Admiralty metal, long a standard for power plant condenser tubes, works satisfactorily in most installations, but other alloys may be necessary in some circumstances. Revere Copper and Brass, Inc.

262 Tube Cleaners — Catalog 76-A provides 48 pp of information on manufacturer's line of tube cleaners. Following equipment selection and operating hints, this practical catalog describes and pictures cutter heads and drill heads, brushes, and motors, giving sizes, application information. Air valves, hose, lubricators are described. Thomas C. Wilson, Inc.

OTHER EQUIPMENT

263 Steam Accumulator — How the steam supply and demand can be balanced by means of company's steam accumulator is told in Bulletin RA-52-8. Stresses reduced boiler capacity required and increased boiler efficiency afforded by use of the accumulator, other advantages. Discusses operating principle, tells how to figure capacity. Foster Wheeler Corp.

264 Fluid Drives — Bulletins 9419 and 9519 are an illustrated catalog and selection guide on company's new Type V8 Class 2 Gyrol fluid drives. Catalog discusses advantages and applications of the drives, covering speed control, power savings, simplified installation etc. A sec-

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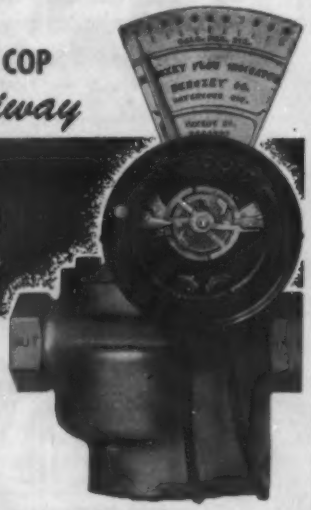
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tional view shows construction and principle of operation. Dimensions for six sizes of drives are provided. Selection guide consists of tables indicating proper drive to use with motors from 7.5 to 800 hp. Separate tables cover variable and constant torque loads. American Blower Corp.

265 Water Heaters — Illustrated 6-pp Bulletin 70, Section 1, on instantaneous type water heaters contains detailed capacity and dimension tables for two-, four- and six-pass designs, removable tube bundles. Davis Engineering Corp.

266 For Burning Refuse Fuel — This 8-pp bulletin describes refuse fuel burning equipment, including a pneumatic refuse fuel distributor which spreads refuse fuels such as bark, wood chips, and bagasse uniformly over the grate surface. Discusses construction features of various components, the selection of grates, as well as pertinent design and engineering features. Riley Stoker Corp.

267 Corrosion, Abrasion Control — Modern practices and products for the positive protection of metal equipment from the effects of corrosion and abrasion are described in this 16-pp bulletin. Covers factory and field application of rubber or synthetic linings to metal parts or products, and maintenance coatings available for application by plant personnel. Also gives detailed information on accelerators, thinners, primers. Goodall Rubber Co.

268 Steam Atomizing Oil Burners — Sixteen-pp illustrated Bulletin 21 describes steam atomizing oil burners and auxiliary equipment for use with heavy oil or tar in boilers, stills, dryers and other furnaces, where steam or compressed air is available for atomizing the oil. Includes information on furnace design and construction. National Airoil Burner Co., Inc.

269 Heat Transfer Apparatus — Condensed Bulletin HT-1 highlights representative products in company's line of heat transfer equipment. Includes oil heaters and coolers, strainers, evaporators, heat exchangers, radiafin air coolers, tubes, pipes, and coils. Cross-section views of typical units are shown, brief descriptions given, and references to other bulletins are listed. Schutte and Koerting Co.

270 Selecting a Blowdown System — A simplified chart for calculating savings possible through heat recovery with a properly sized automatic continuous blowdown system is offered in this pamphlet. Chart is based on total dissolved solids in the boiler water and the permissible concentrations. Henszey Co.

271 Steam Turbines — The advantages of company's solid wheel turbines, axial flow turbines, single stage and multistage, are outlined in illustrated Bulletin S-140. Describes various models in their line and includes application photos. The Terry Steam Co.

272 Turbine Speed Control — Thirty-pp wire-bound Bulletin H-21 is titled, "Fundamentals of Turbine Speed Control." It is an elaborately illustrated, educational booklet intended to clarify the operation of common types of automatic speed control for steam turbines. An introductory section covers general fundamentals of automatic control systems, and includes a key to control terminology. Simplified diagrams show operating principles of actual control systems. Elliott Co.

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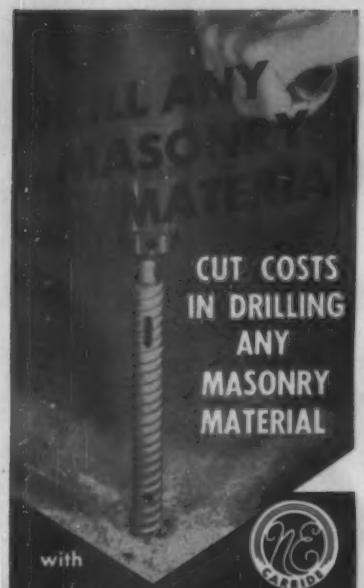

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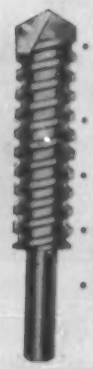

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273 Dust Collection — Aerodyne dust collectors in chemical processing and other industries are discussed in 8-pp Bulletin 171. Explains theory and design of collector system, includes drawings of the various types covered. The Green Fuel Economiser Co., Inc.

274 Preheating Combustion Air — This well-illustrated 36-pp booklet explains fuel savings and increased performance made possible by using waste heat in flue gases to preheat incoming combustion air. Also covers increased boiler output, ability to use lower grade fuels, other advantages afforded. Booklet contrasts regenerative with recuperative preheaters; explains operating principle and structural details of the Ljungstrom air preheater. Applications for other than power boilers are also covered. Air Preheater Corp.

275 For Climate Control — Bulletin 122, 8 pp, introduces an air conditioner designed for precise and economical control of air temperature and moisture. Illustrates design of the new machine, tells its features, and pictures some installations. Tells how it is used in heating and cooling processes. Niagara Blower Co.

Postage-free cards for ordering catalogs are on page 118. You may also use the cards to order literature mentioned in the ads.

276 Steam Condensers — Some recent additions to this company's power plant condenser installations are pictured and described briefly in this 24-pp booklet. Also included are an engineering section on condenser design factors, and sections devoted to air removal equipment, to steam condenser specialties, and to maintenance services available. Condenser Service & Engineering Co., Inc.

277 Data on Insulations — Insulation solutions for a wide range of temperature problems are charted in this folder. Provides brief descriptive information and tells forms available for high temperature applications, for intermediate temperature use, for hot and cold water and low pressure steam, for ice water and frigid temperatures. Mundet Cork Corp.

278 Refrigerator Condensers — Bulletin RC-2, 38 pp, utilizes drawings, tables and engineering data to show how to select proper type from company's line of ammonia and Freon condensers for refrigeration services. Illustrates horizontal multipass shell and tube types; vertical singlepass shell and tube types. Gives pipe sizes for ammonia and Freon lines. Henry Vogt Machine Co.

279 Petroleum Pitch — This illustrated article on petroleum pitch as a boiler fuel stresses its low cost, other advantages. Explains combustion of pitch; discusses unloading method, burning, storage, fuel oil treatment, also precautions in handling hot pitch. Kor Corp.

280 Packings and Gaskets — Catalog P-100C, 32 pp, covers 95 most popular packings and gaskets in company's line, furnishing details of construction, service recommendations and size information. Includes charts showing specific recommendations for many applications. Packing Div., Raybestos-Manhattan, Inc.

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NEW ENGINEERING BOOKS

Methods of Reasoning, by P. D. Scott, Size 8½ by 11 in., 16 pages, 15,000 words, paper covered. Published by Cleveland Engineering Society, 2136 East 19th St., Cleveland 15, Ohio. Price $1.00.

The author of "Methods of Reasoning," P. D. Scott, has had 25 years of experience in training engineers and technical personnel. This book is a distillation of that experience. It sets forth in a practical, understandable manner the processes by which anyone can teach himself to reason scientifically and make sound decisions in his job, home, and family relationships. Recommended reading for anyone with large or small problems to solve.

★ ★ ★

Heat Transfer and Fluid Dynamics, by J. G. Knudsen and D. L. Katz. Size 6 by 9 in., 243 pages including index. Published by Engineering Research Institute, University of Michigan, Ann Arbor, Mich. Price: paper binding, $3.50; cloth binding, $4.50.

This book is divided into three general sections, the first section dealing with turbulent and laminar flow of fluids over plates, through cylinders and tubes, between parallel planes, in annuli and spheres. The second section is devoted to the study of energy dissipation and shows how losses can be figured. The third section of the book discusses heat transfer by convection, and points out the significance of fluid dynamics in this phenomenon.

A knowledge of the behavior of fluids is important in some engineering work and this book will prove a valuable guide and reference work for those engineers who are concerned with the dynamics of fluids and heat transfer. It is advisable, however, that prospective readers of the book be equipped with a knowledge of the calculus and differential equations for a good appreciation of the material presented.

★ ★ ★

Magnetic Control of Industrial Motors, Second Edition, by Gerhart W. Heumann. Cloth binding, 714 pages, 9¼ by 6 in. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. Price $9.50.

This is the second edition of a book first published in 1947. In his preface to the first edition the author said: "There are two major aspects of control, design and application. . . . This is intended to be an application book. Its aim is to explain performance of motors, characteristics of control devices, and the function of commonly used control circuits."

In the seven years since the book was written, the control industry has grown in size and complexity, and this second edition has been brought up-to-date with recent advances in the field. It has been expanded by about 20 per cent, and contains much new material on adjustable voltage and regulating systems, particularly with regard to rotating and magnetic amplifiers. The reference material in the book has been thoroughly modernized, and emphasis has been placed on the theoretical background underlying recognized National Standards and Safety Codes. Considerable stress has been placed on explaining the rules of the National Electrical Code which apply to motor controllers.

As an aid to teaching industrial control subjects, problems have been added to many chapters. These problems have been modeled on those with which practicing engineers are confronted in their day-to-day design and application work.

The first part of the book is occupied with explaining the external performance characteristics of all types of industrial motors, since the performance of control equipment depends on desired motor behavior. This is followed by a discussion of components and devices available to the control system designer. Basic circuits are given which show motor performance required for industrial drives. The practical applications of these building blocks are illustrated by examination of widely used general and special controllers.

This book will help the reader to select, quickly and accurately, the proper type of controller for a given industrial control application.

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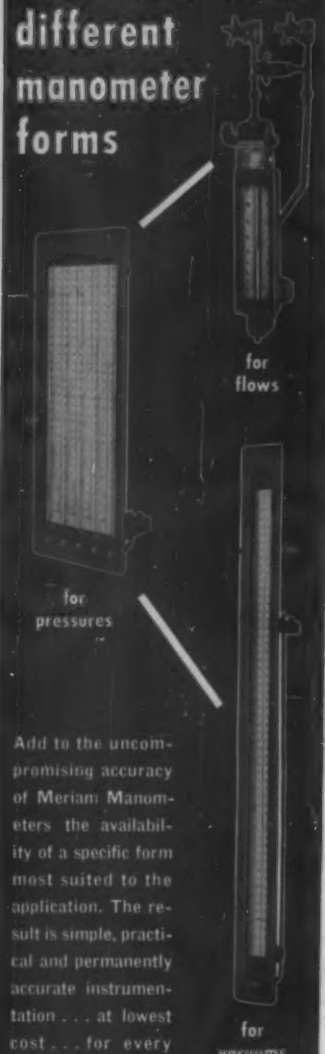

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EQUIPMENT NEWS

continued from page 58

31—TIME DELAY RELAY is pneumatically controlled

An electrical interlock in a circuit which allows push button control can be obtained by use of an instant action auxiliary switch in the Model NEL Agastat Time Delay Relay, it is announced. The unit is for operation on energization. Time delay is pneumatically-controlled and provides a readily adjusted and accurate timing interval from 0.1 sec to 10 or more minutes. Measuring 2½ in. wide, 3⅝ in. deep and 4⅛ in. high, the Agastat is a compact unit, easily mounted. Affixed to front is a normally closed double-throw micro-switch.

Contacts of this switch are kept in open position by a lever connecting auxiliary switch and core of Agastat. When coil is energized, core jumps up and these contacts close instantly, allowing interlock. Simultaneously, time delay period starts and continues to preadjusted time delay at which main switch trips transferring contacts. In de-energization, auxiliary switch contacts change to open position and main contacts transfer. Agastat is available for all a-c and d-c voltages, in single-pole, double throw, double break and double-pole, double-throw, single-break models. It is rated 15 amp at 115 v, 60 cycle a-c. A'G'A Div., Elastic Stop Nut Corp. of America.

32—MOLDABLE METAL is an aluminum-based paste

Lab-Metal is announced as an improved cold metal solder — an aluminum-based compound in paste form. Upon drying it hardens to form a strong permanent bond to metal, wood, plaster, glass or plastic, says manufacturer, providing a hard, rustproof, waterproof, metallized surface. Its use is simple, since neither heat nor mixing is required. It spreads with a putty knife.

Lab-Metal takes many of its characteristics from its main ingredient — aluminum pigment supplied by Aluminum Co. of America. This pigment when compounded with the resin dries to form a surface which will not shrink, crack,

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chip or peel, it is stated, and which may be covered with paints, primers, lacquers or enamels. The solder itself may be filed, drilled, chiseled, tapped or ground, or sanded to a feather edge. Lab-Metal is reported to withstand temperatures up to 350 F or down to −40 F, to have a tensile strength of 650 psi. It is claimed to be unaffected by mild acids, alcohols, toluene, ether, petroleum and petroleum solvents. Alvin Products, Inc.

Reader Service Cards on pages 117–118 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

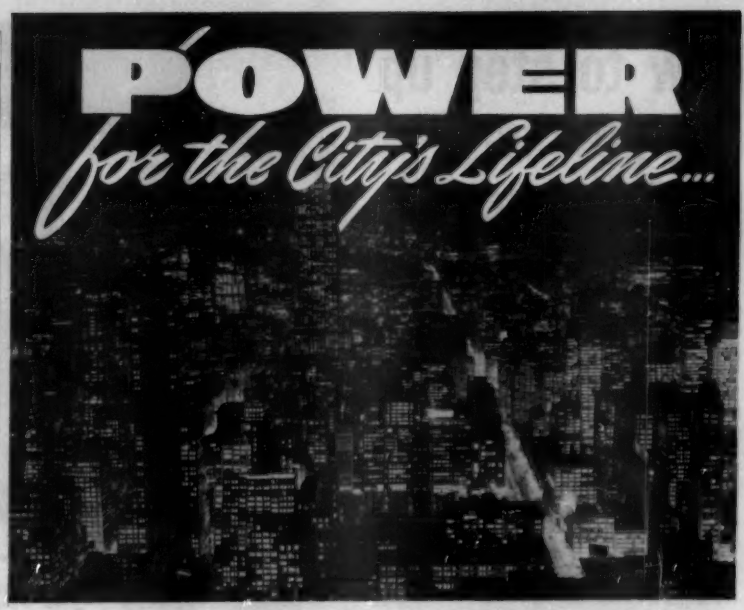
33—ULTRASONIC FLOWMETER measures mass or volume flow

Described as a basically new flowmeter which measures either mass or volume flow or virtually any fluid regardless of its electrical conductivity and without being affected by accompanying variables, this instrument is the development of the W. L. Maxson Corp. and is being manufactured by Fischer & Porter Co. Pressure drop of the flowmeter is virtually zero, it is stated; built

into a short pipe section, it has neither restrictions nor moving parts which might obstruct flow.

Rate of volume flow is measured by two transducers, each of which transmits and receives controlled pulses of ultrasonic energy across the pipe section — one diagonally upstream and the other diagonally downstream — sensing the difference in the number of pulses received. An increasing flow rate increases the number of downstream pulses and decreases the upstream ones. Repetition rate of these pulses cancels out sonic velocity by heterodyne techniques, leaving only the difference in repetition rate which is proportional to flow velocity. According to manufacturer, this system eliminates effect of temperature and density on sonic velocity, so that flow measurement is unaffected by them.

A third transducer, acting alone, may be added to the volumetric flow-rate meter to give density measurement, converting the instrument into a mass flowmeter. Conventional voltage indicators may be used for either volume flow or mass flow output signal. Totalization of mass transferred may be accomplished by integration of the gravimetric rate signal, using built-in analog computer. Although its application has not yet been fully explored, the new meter is reported



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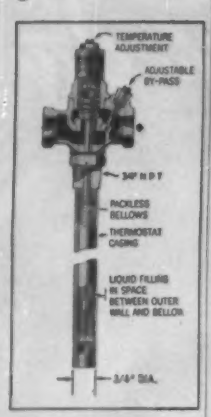

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suitable for measurement of practically all fluids, including petroleum, kerosene, chemicals, foods, most slurries, aqueous solutions and liquefied gases. Present designs have a capacity up to 12,000 lb per minute with a fluid density range of about 2.5 to 1. Fischer & Porter Co.

34—HORIZONTAL MOTORS for direct connection

Uniclosed Horizontal Motors with face type mounting brackets for direct connection to driven equipment are built to rerated NEMA specifications and extremely compact — offering more horsepower in less space. They may have NEMA Style C brackets which accommodate bolts from the driven machine, or Style D for bolting from motor side. They come in 1- to 30-hp ratings. U. S. Electrical Motors Inc.

35—AIR CONDITIONERS, low, floor type, package units

This line of floor type air conditioning units feature lower overall height and includes five sizes from 3 to 15-tons for installation in public buildings and institutions. Discharge plenums are about 8 in. shorter in height than many units. Reduced height is effected through use of two cold flow diffuser grille sections containing curved blades which direct cold air up and away from the conditioner. And even though diffuser grille height is less than 6 ft, the blade curvature eliminates direct cold air flow at head height, it is pointed out. Also, the blades are designed to impart a turbulent, swirling motion to the cooled air as it leaves the conditioner to speed air diffusion through conditioned area.

These air conditioners are self contained units with water-cooled condensers, and heavy fiber glass insulation which contributes to cooling efficiency and also serves as a sound deadener. They can be provided with steam or hot water coils for heating. The units are painted on all surfaces with rust inhibiting prime and finish coat. Condensate drains into a drip pan with external connection. The two smallest sizes can be shipped fully assembled. American Blower Corp.

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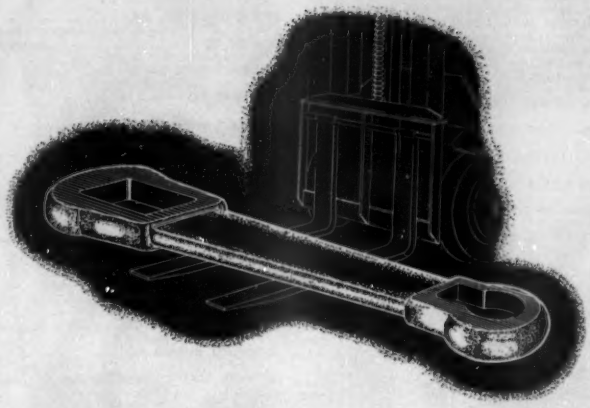

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there's much
to be seen
in space
198 and 217

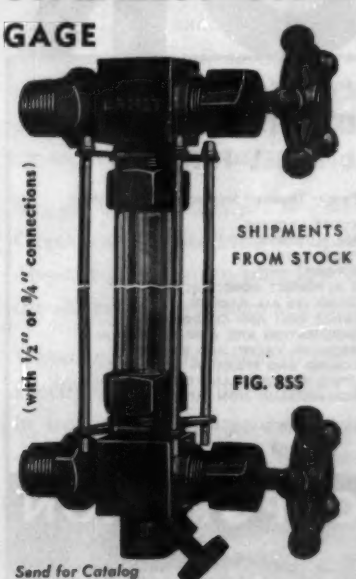
75th
anniversary
POWER SHOW
CHICAGO COLISEUM
NOVEMBER 14-18

ALLIS-CHALMERS

A-4873B

For more data circle 576 on Post Card

ERNST
STAINLESS STEEL
GAGE



SHIPMENTS
FROM STOCK

FIG. 855

Send for Catalog
Phone Livingston 6-1400
ERNST WATER COLUMN & GAGE CO.
LIVINGSTON, N. J.

For more data circle 575 on Post Card

A higher standard
for standard boilers!

Boilers, no matter what the application, can be very much alike in basic design. However, the Bros "S" Type Boiler (illustrated above) has in it many distinct features, selected over years of experience which result in:

1. *Higher burning efficiency*
2. *Lowest possible maintenance costs*
3. *Minimum space requirements*
4. *Simplified installation*

Bros "S" Type Boilers are pre-engineered to use standard components. This permits faster delivery and field assembly at a much lower cost.

If you are planning a new plant ... expanding ... or replacing an old unit, be sure to get full information on Bros "S" Type Boilers. Capacities range from 10,800 to 50,000 lbs. per hr. with design pressures up to 600 psi.

Write today for your copy of the new "S" Type brochure. It contains complete specifications and drawings.

POWER DIVISION — **WM. BROS BOILER & MFG. CO.**

1057 Tenth Avenue S.E. BROS Minneapolis 14, Minnesota

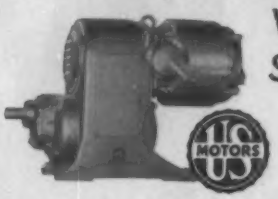
DESIGNERS AND MANUFACTURERS OF WATERTUBE BOILERS, 2-3-4 DRUM AND PACKAGED DESIGNS, AUXILIARY EQUIPMENT, AND A FULL LINE OF INDUSTRIAL STOKERS.

For more data circle 577 on Post Card

3 GREAT FEATURES
Unique with

U. S. VARIDRIVES

... for dependable, long-life, Variable Speed



With a U. S. Varidrive motor you can get instantly all the speeds needed for every operating condition. You can have infinite speeds at your instant command without resorting to cumbersome speed-changing contraptions and costly external equipment. The Varidrive combines all equipment in one compact "package," occupying little more space than an ordinary motor, for convenient installation.

1 AUTOTAUT TENSION CONTROL

Autotaut automatically compensates for wear, stretch and changes in length of the belt drive, without manual adjustment. Exact tension is obtained by a live, resilient spring which has been accurately calibrated at the factory.

2 DOUBLE-RIBBED BELT

With the double-ribbed design, smaller diameters and greater speeds can be combined with maximum motor compactness. The Varibelt provides double corrugation reduces internal friction.

3 SLIDING SPLINE

The U. S. Varidrive gears the shaft and sliding Varidisc together with an involute spline. Integral teeth maximum strength with minimum diameter, and reduce wear and vibration.

U. S. MOTORS

U. S. ELECTRICAL MOTORS INC. PE-11
P. O. Box 2058, Los Angeles 54, Calif., or Milford, Conn.
Ask for Booklet #1797

NAME_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

For more data circle 578 on Post Card

NEW! Re-Designed

Babbitt *Adjustable* SPROCKET RIM *with Chain Guide*

ANY VALVE is readily accessible *from the floor* with low-cost Babbitt Sprocket Rim. Now re-designed for—

- **Greater strength**
- **Easier, quicker, more solid assembly**

Simplifies pipe layouts, prevents accidents, fits all valve wheels. Your supplier carries complete stocks. Call him — or write for folder and prices.

Babbitt STEAM SPECIALTY CO.

4 BABBITT SQUARE, NEW BEDFORD, MASSACHUSETTS, U. S. A.

For more data circle 579 on Post Card

KOR

pronounced "core"

SLUDGE DISPERSANT AND STABILIZER FOR ALL DIESEL FUEL OILS

Increases Engine Power Through Improved Combustion

- PREVENTS INJECTOR STICKING
- PREVENTS FILTER PLUGGING
- INCREASES CETANE RATING
- LOWERS POUR POINT
- KEEPS VALVES IN PERFECT CONDITION
- COMPLETELY DISSOLVES ALL SLUDGES
- PROTECTS AGAINST RUST AND CORROSION
- RESTRAINS CONDENSATION AND ACID FORMATION
- PREVENTS CARBON ON VALVES AND INJECTORS
- RESTRAINS SMOKING AND SPARKING
- UTILIZES ALL BTU'S IN SLUDGE AND OIL
- NON-TOXIC, NON-METALLIC, NON-EXPLOSIVE

KOR MAKES TODAY'S OIL FUELS BETTER

SEND FOR PRICES

KOR CORPORATION

Division of Oxi Corporation

MANUFACTURING, ENGINEERING, AND COMBUSTION SPECIALISTS

600 WEST 9th AVENUE, GARY, INDIANA

For more data circle 580 on Post Card

Only Chapman Tilting Disc Check Valves give you

FAST TIGHT QUIET CLOSURE

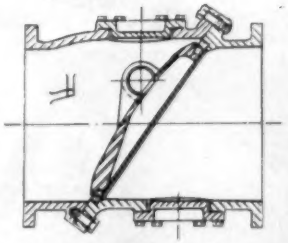
Fast, quiet operation means low cost operation for check valves. That's exactly what the Chapman Tilting Disc Check Valve is designed to do. It won't flutter or slam and damage the piping joints or the valve itself. The unique drop-tight closure action eliminates scraping and wear of the disc and seat.

Rugged construction and low wear of the Chapman Tilting Disc Check Valves mean long life under severe operating conditions. Absence of vibration plus low head loss keep maintenance of the entire piping system at a minimum.

Whether for replacement or for new piping systems, be sure to specify Chapman Tilting Disc Check Valves. They're available in iron and steel for handling fluids or gases under a wide range of pressures. For full data on the complete line, write today. Ask for Catalog 30-A.

The Chapman Valve Mfg. Co.
INDIAN ORCHARD, MASSACHUSETTS

Here's why Chapman's Tilting Disc Check Valves Keep Quiet All of Their Lives



This specially designed "airfoil" disc balances perfectly in open position. The fluid holds the disc tightly against its stops without flutter. The body of the valve is larger around the disc, so the net valve area is at least as much as the pipe area to assure low flow resistance.

When the flow is reversed, pressure against the upper part of the disc cushions it as it closes. Then the disc drops easily and tightly to its beveled seat after the valve has swung closed. Seating is fast and quiet with minimum head loss in all but unusual piping arrangements.

For more data circle 581 on Post Card

Reaction kettle for making ion exchange resins at The Permutit Co., Birmingham, N. J.

Why we make our own ion exchange resins:

First—in order to offer our customers the best resins.

But the main reason we make our own resins is that we can "tailor" their molecular design, chemical and physical characteristics to best meet process and equipment requirements. It gives us greater control of capacity, efficiency, stability and mesh size.

It also supplements our production of other types of zeolites with the result that Permutit (and only Permutit) makes all widely used types of ion exchangers . . . from rugged natural greensands for simple, low-cost water softening to specialized resins for purifying chemicals.

And it enables us to offer an integrated Water Conditioning Service including water analysis, engineering, equipment, controls and the ion exchange material itself . . . from one source . . . under one responsibility. That's how "weak links" can be avoided. That's why Permutit equipment gives long years of trouble-free service.

For further information, write The Permutit Company, Dept. PE-11, 330 West 42nd St., New York 36, N. Y.

PERMUTIT®
WATER CONDITIONING
Equipment • Resins • Experience

For more data circle 582 on Post Card